

THURSDAY, JUNE 1, 1876

SCIENTIFIC WORTHIES

VIII.—CHARLES WYVILLE THOMSON

CHARLES WYVILLE THOMSON was born at Bonyde, a small property in Linlithgowshire, which had been long in his family, on the 5th of March, 1830. All his early associations were with Edinburgh; his father was a surgeon in the East India Company's service, and spent most of his life abroad; but his grandfather was a distinguished Edinburgh clergyman, and his great-grandfather was "Principall Clerke of Chancellary" at the time of the rebellion of 1745.

Wyville Thomson got most of his schooling at Merchiston Castle Academy, at that time under the excellent management of Mr. Charles Chalmers, brother of the famous divine. He left school and began the medical course in Edinburgh University in the year 1845. After studying for three years he fell into somewhat delicate health from overwork, and while still scarcely more than a lad, in 1850, to gain a year's rest, he accepted the lectureship on botany in King's College, Aberdeen. In the following year he was appointed lecturer on the same subject at Marischal College and University, which University conferred on him the degree of LL.D. He at this time was an indefatigable worker among the lower forms of animal life, and published several papers on the Polyzoa and Sertularian zoophytes of Scotland. Even at this time some of his philosophical speculations as to the development of certain Medusoid forms attracted notice, though they appear to have been considered too daring by Johnston, of Berwick-on-Tweed, and Edward Forbes. What would these worthies say, if they were living now, about the study of Ontogenesis as it at present exists amongst us?

Towards the close of 1853 a vacancy arose in the Professorship of Natural History (Botany and Zoology) in the Queen's College, Cork, owing to the resignation of the Rev. W. Hincks, F.L.S., and on August 26 Wyville Thomson received the appointment. He had, however, hardly settled down to the duties of this professorship, when a vacancy occurred in the Professorship of Mineralogy and Geology in the Queen's College, Belfast, by the resignation of Fred. McCoy, who had been elected to one of the professorships in the New University of Melbourne. Wyville Thomson applied to be transferred to the Belfast chair, and was appointed thereto in September 1854.

The next five years were years of busy work for him. In addition to courses of lectures on Geology and Mineralogy, he laid the foundation and built up a good deal of the superstructure of the present excellent Museum of the Queen's College, Belfast. In addition to many papers on zoological subjects, published by him at this date, we may mention one on a genus of Trilobites, read before the London Geological Society, and on a new fossil Cirriped, published in the "Annals of Natural History."

The study of fossil forms without a good knowledge of existing forms is in itself most useless, and a palæontologist of this sort is after all little more than a cataloguer;

such was not Wyville Thomson. At this time, one fascinating group of the Echinoderms (the Lily Stars) attracted his attention, and while investigating the immense assemblage of extinct forms belonging thereto, he determined to know all that could be known about the life history of the few living forms. True, the illustrious Vaughan Thompson had some thirty years previously discovered and described a British Pentacrinus, and had determined that it was but the young stage of our common though beautiful rosy feather-star; but a great deal remained to be done ere the history of even this form was complete, and it was not until the close of 1862 that Wyville Thomson's researches were sufficiently advanced to enable him to lay them before the Royal Society. They have since been published in the volume of the Philosophical Transactions for 1865, and it is not too much to say that this memoir will ever be a witness of the author's acute and accurate powers of research. The illustrations are all from exquisitely finished sketches by the author, and show a most enviable power of drawing, an art almost indispensable to the naturalist. These investigations into the pentacrinoid stages of Comatula were but part of a series of observations on the genus Pentacrinus itself, and Wyville Thomson amassed a lot of material with the object of writing a memoir on the group.

About 1864 the son of the illustrious Michael Sars, Professor of Zoology in the University of Christiania, was one of the Acting Commissioners of Fisheries for Norway, and as such was engaged in a series of scientific investigations as to the fisheries on the Lofoten Islands, situated on the north-west coast of Norway. One day, dredging in water about 700 feet deep, for the purpose of determining the condition of the sea-bed, he obtained a number of specimens of a strange Crinoid, which at once struck him as being not unlike the pentacrinoid stage of *Comatula Sarsii*, with which he was familiar.

Here it is but right to mention that almost up to this date, men of science seemed to have made up their minds that life did not and could not exist below a certain depth of the sea. There were, according to Edward Forbes, fixed zones of depth. 1st, the littoral zone, between low and high water-marks; 2nd, the Laminarian zone, from low water to a depth of fifteen fathoms; 3rd, the Coralline zone, from the fifteen-fathom line to a depth of fifty fathoms; and 4th, the zone of deep-sea corals extending from the edge of the Coralline zone to an unknown lower limit. "In this region, as we descend deeper and deeper, its inhabitants become more and more modified and fewer and fewer, indicating our approach towards an abyss where life is either extinguished or exhibits but a few sparks to mark its lingering presence." Though the very general idea entertained by naturalists was that the depths of the sea were destitute of life, yet from time to time remarkable specimens were without doubt brought up from very great depths, and these occurrences, some of which were known to Forbes, had the evident effect of making him, during the later period of his life, write cautiously on the subject. The reader who would care to know all that is known as to the records of the existence of life up to 1865, will find a full account thereof in Wyville Thomson's "Depths of the Sea."

G. O. Sars lost no time in announcing to his father his interesting discovery, and, acting on Prof. Sars's advice, he

went on dredging at depths of from 700 to 800 feet, finding an abundance of animal life. In the meanwhile the elder Sars, knowing that Wyville Thomson was working on the subject, sent him word of his son's discovery, of the significance of which he was still in doubt, and invited him to Christiania to see the specimen. He went, and on going over the matter together they came to the conclusion that the new Lily Star seemed to be closely related to a genus called *Bourgueticrinus*, a well-known fossil, and was consequently a degraded form of the family Apocrinidae. This was a startling discovery; it seemed now almost certain that there had been found not only a living representative of a long lost group, but a form that might be regarded as having lived on from the great Chalk epoch even into ours. In the train of thought thus excited, we think we see the material for speculation, then a fixed determination to prove—is this speculation true? then the trial trip in the *Lightning*, the more extended survey in the *Porcupine*, and lastly, all the brilliant results of the most remarkable voyage of discovery ever made, in the *Challenger*. It is not right to anticipate, and in pursuing our sketch we must not forget to mention that in 1860 Dr. Dickie, who was then a colleague of Wyville Thomson's as Professor of Natural History in the Queen's College, Belfast, was appointed to the Chair of Botany at Aberdeen, and at first temporarily and afterwards permanently, Wyville Thomson lectured on zoology and botany, becoming thus in very deed Professor of Natural History in the Queen's College, Belfast.

Prof. Wyville Thomson was, however, something besides a mere enthusiastic biologist; he was not merely content with rapidly increasing the zoological treasures of the Queen's College Museum; he did more. By interesting himself not only in what concerned the working of the College, but even in the welfare of the town in which it was located, he soon gathered round him a host of intelligent and warm-hearted friends. In social life it was but an accident that would reveal the Biologist, and one witnessed only the general culture and the artistic taste of a well-bred man. On one occasion of great moment in the history of the Queen's University in Ireland, Wyville Thomson's influence was felt, as we believe, for good. In 1866 a Supplemental Charter was given by the then Government to the Queen's University to enable it to confer degrees on students who might come up from any College that might be recognised as such by the Senate of the Queen's University. It seems hard to believe that such a charter should have been granted, for it might have given to any large school a position of equality to the three Queen's Colleges, and so have practically destroyed all middle-class education in Ireland. Wyville Thomson saw that the interests of education were at stake, and with commendable promptness and immense energy he initiated the formation of a committee and the collection of a sum of several thousands of pounds to try the validity of the new Charter in a court of law. In this the committee were successful, for the Charter was rendered inoperative by an injunction granted in 1867, after long and protracted arguments, by the then Master of the Rolls in Ireland.

Wyville Thomson was vice-president of the jury on raw products at the Paris Exhibition in 1867; he took the lead in organising the very flourishing School of Art in

Belfast under the Science and Art Department, and was the first chairman of the Board of Directors. He is a Conservative in politics, and a magistrate and Commissioner of Supply for the county of Linlithgow.

In 1868 Dr. Carpenter, at that time one of the vice-presidents of the Royal Society, paid Prof. Wyville Thomson a visit in order that they might work out together the structure and development of the Crinoids. As the friends discoursed about these Lily stars, Wyville Thomson told Carpenter of his own firm conviction that the land of promise for the naturalist, indeed the only remaining region where there were endless novelties of most extraordinary interest, was the bottom of the deep sea; here were treasures ready to the hand which had the means of gathering them, and he urged him to use his influence at head-quarters in London to induce the Admiralty to lend to science, for a time, some small vessel properly fitted with dredging gear and the other necessary scientific apparatus, so as to definitely settle all these weighty questions. The Admiralty gave their sanction to the use of a Government vessel for the investigation, and the surveying ship *Lightning* left Oban for a cruise in the North Atlantic Ocean in August, 1868, returning to Oban by the end of September. For an account of this cruise we must refer to the "Depths of the Sea." The results of the *Lightning* expedition were fairly satisfactory. It was shown beyond question that animal life was varied and abundant at depths in the ocean down to between 600 and 700 fathoms; and it had been determined that great masses of water at different temperatures were moving about, each in its particular course; and, further, it had been shown that many of the deep-sea forms of life were closely related to fossils of the Tertiary and Chalk periods.

In 1869 the Admiralty once again acceded to the request of the Royal Society, and assigned the surveying vessel *Porcupine* for a survey to extend from May to September, 1869. The 1869 survey divides itself into three sections; the first when the *Porcupine* surveyed off the west coast of Ireland, Mr. Gwyn Jeffreys being in scientific charge; the second in the Bay of Biscay, in charge of Wyville Thomson; and the third, in which the track of the *Lightning* was carefully worked over, and all previous observations were duly checked.

Once again, in 1870, the Admiralty placed the *Porcupine* at the disposal of the Royal Society, and it was arranged that the year's expedition should be divided as in 1869, into cruises. Mr. Gwyn Jeffreys was to undertake the scientific direction of the first cruise from Falmouth to Gibraltar, and Wyville Thomson and Dr. Carpenter were to relieve him at Gibraltar, and to superintend the survey of the Mediterranean. Unfortunately a severe attack of fever prevented Wyville Thomson from joining the *Porcupine* at Gibraltar, and Dr. Carpenter took charge of the scientific arrangements.

In 1869 Wyville Thomson was elected a Fellow of the Royal Society.

In 1870 Dr. Allman resigned the Professorship of Natural History in the University of Edinburgh. Wyville Thomson was a candidate for the vacant chair, and amid the hearty congratulations of all men of science he was elected, vacating the chair in the Queen's College, Belfast, to which Dr. Cunningham was appointed.

On the return of the *Porcupine* from her last cruise, so much interest was felt in the bearings of the new discoveries upon important biological, geological, and physical problems, that a representation was made to the Government by the Council of the Royal Society, urging the despatch of an expedition to investigate each of the great oceans, and to take an outline survey of that vast new field of research, the bottom of the sea. The proposition of the Royal Society met with great and general support, and the *Challenger* was fitted out as England never before fitted out a vessel for scientific research.

The University of Edinburgh having given their consent, Prof. Wyville Thomson accepted the post of Director of the Civilian Staff; for this post none could have been better qualified; through his energy was it that this question of what lived in the ocean depths came to be investigated at all; the practical experience he had now gained could not be better utilised, while the subjects to be worked out were all within his reach. Able as a biologist to hold a high position, he combined with this more than an ordinary knowledge of chemistry, mineralogy, and geology, a knowledge far more than enough to enable him to encourage and sympathise with the labours of his staff.

The *Challenger* has now returned to our shores, her mission worthily accomplished, her officers and crew in the best of health and spirits.

All England welcomes Prof. Wyville Thomson back again, and thanks him for his voluntary exile of three and a half years from home and wife and friends for Science sake; and while we congratulate him on having laid a new realm at our feet and on having given us new food for thought, may we express in addition the hope that he will not long delay to give to the world the narrative of a cruise novel in its conception, successful in its results, and destined to live long in story.

THE CRUELTY TO ANIMALS BILL

IT is important that those who understand the national importance of science, as well as those who know how completely the art of medicine depends upon physiology should agree upon a common defence, now that both are so seriously threatened by legislation.

We do not think that scientific investigators can fairly claim to be entirely free in their choice of methods, on account of the importance of their objects, the purity of their motives, or the respectability of their character. Claims to absolute immunity from the interference of the State were maintained on precisely the same grounds by Churchmen in the Middle Ages, and the result proved how dangerous it is for any class of men to seclude themselves from the healthy atmosphere of free criticism and from contact with the popular conscience. A much better plea might be found in the small number of physiologists in this country, and in the important fact that, after many months of agitation and invective, their enemies were not able to bring before the Royal Commission a single authentic instance of cruelty. Still, considering the strong popular feeling on the subject, there are probably few who will deny that some legislation is necessary, if only to save physiologists spending their whole time in writing newspaper articles and going on deputations to Ministers.

What scientific men have a right to demand is that any regulations made should interfere as little with their legitimate objects as is compatible with the purpose of legislation. No one except a few obscure fanatics pretend that it is never lawful to subject animals to pain, or even to death, for self-preservation forbids such a rule; and no one can maintain that it is right to bleed calves and swallow oysters alive, for luxury, to geld horses for convenience, and hunt hares to death for sport, and yet that it is wrong to give one animal a disease that we may learn how to prevent or cure the same disease in thousands, or to perform a well-considered experiment which will certainly increase our knowledge of the laws of our being, and, more or less probably, tend to the relief of human suffering.

It is, therefore, of great importance that none of the objects which justify experiments on animals should be sacrificed in the effort to save the rest. Teachers of physiology in large and well-equipped schools might be content with a registration Bill which would leave them unmolested and forbid all research to outsiders; physicians and surgeons might demand liberty to do anything they choose which has a direct and immediate bearing on the relief of human suffering, and this appeal to self-interest would probably always be successful; independent investigators might see, without complaint, the teaching of physiology reduced to a study of words and opinions, and the advance of medical knowledge brought to a standstill, so long as they were left in peace. But such short-sighted narrowness would bring its own punishment. The results of independent research can only be obtained by those who have themselves been trained in genuine workrooms and can only be properly criticised by a properly instructed audience. Teaching without any attempt at original observation soon becomes lifeless and inexact; and medicine is far less indebted to experiment for the knowledge of the effect of certain drugs or operations, than for the broad basis of demonstrated facts as to the functions of the healthy organism on which all rational attempts to remedy them when disturbed must depend.

The scientific objects, then, which must, if possible, be protected from the mischievous Bill now before Parliament are, first, freedom of original investigation by competent persons; secondly, freedom of teaching by necessary demonstrations; and thirdly, freedom of experiment with the definite aims of the practical physician.

The best method of securing these objects while preventing the stain of cruelty from debasing the fair fame of science, would probably be that indicated by the Report of the Royal Commission. Laboratories would then be licensed under the control of responsible persons. Special certificates would be granted to competent investigators who, from distance or other causes, were not able to make use of these laboratories. The advance of sound physiological knowledge as well as the direct prevention or cure of disease, would be recognised as a legitimate object of experimental inquiry. The general condition of the licence or certificate would be that every experiment on a living animal should be rendered free from pain by the skilled use of chloroform (or other anæsthetic better adapted to the animal), except when this would defeat the object of the inquiry, and happily these exceptions

need be very few. Lastly, inspectors might fairly be appointed to see that not only in the actual experiments, but in the feeding, housing, and general treatment of the laboratory animals there was neither parsimony nor carelessness. The licence would be given on suitable recommendation by the Home Secretary, with power of revoking it for abuse, subject to appeal, as suggested in the Royal Commissioners' Report.

Under such an Act physiologists might fairly be expected to make it a point of honour that its provisions were fully carried out in spirit as well as in letter. The framers of the present Bill, by their disregard of physiology as an independent science, to be taught like any other, do their best to render its progress impossible; while, by their absurdly minute limitations, they would make original research almost as impossible as efficient teaching, and deprive the art of medicine of its only safe foundation.

The efforts of all who care for the advance of human knowledge or the alleviation of human misery should be directed to bring the scope of the Government Bill back to that indicated by the Report of the Royal Commission.

THE SCIENCE OF LANGUAGE

Language and its Study. By Prof. Whitney; edited by Dr. R. Morris. (London: Trübner and Co., 1876.)

Leaves from a Word-hunter's Note-book. By the Rev. A. S. Palmer. (London: Trübner and Co., 1876.)

The Aryan Origin of the Gaelic Race and Language. By the Very Rev. U. J. Bourke (London: Longmans, Green, and Co., 1875.)

THESE three books are very fairly characteristic of the present position of comparative philology. The first is a reprint of the first seven chapters of Prof. Whitney's well-known work on the science of language, and has been admirably edited by Dr. Morris with notes and introduction, with special reference to a scientific study of English. The second is just what it professes to be, extracts from a commonplace book on the etymology of various words, and it illustrates very well the influence exercised by a comparative treatment of language upon what used to be the pastime of literary *dilettanti*. Mr. Palmer's derivations have been traced with full regard to the scientific method, and besides being accompanied by a wealth of quotations, rest for the most part on a secure foundation. "The Aryan Origin of the Gaelic Race," again, is one of those books which a few years back would have teemed with the wildest vagaries; the author, it is plain, has little critical judgment, but a diligent study of works like those of Zeuss or Max Müller has kept him in the right path, and though he startles us now and then with such assertions as that the Aryan is "the primeval language of man," or that "there had been only seventeen letters in Greek at the earliest period," his views are in general just and sound. We may doubt whether his theory of the Pagan origin of the Round Towers will be widely accepted, and complain of his prolixity, but the book is a striking example of the extent to which a knowledge of Comparative Philology has spread, and the wholesome influence its principles have exerted.

When we consider that the science of language is a

science of not more than fifty years' growth, as well as the vast amount of details that had to be collected and classified before its creation became possible, its present advanced condition must be a matter of surprise. No doubt there is still very much to be done; some of the main questions connected with the study of language still remain unsettled, and new questions are starting up that will have to be answered hereafter. It is even possible that fresh knowledge and investigation will modify some of the hypotheses which have been accepted as fundamental truths.

Thus it might have been thought that the first question to be settled would be whether the science is to be included among the physical or the historical sciences, and yet this is even now a matter of dispute. There is much to be said in favour of both views. If we look merely to the fact that it lays down the laws in accordance with which thought endeavours to express itself in speech, it must be regarded as a historical science; if on the other hand, we consider that thought can only be expressed in speech by the help of physiological machinery, we are bound to class it among the physical sciences. If we make phonology not only the beginning, but also the end of linguistic science, linguistic science will differ but little from physiology in aim as well as in method; but if we remember that the various sounds which it is the province of phonology to determine and classify do not become language until they embody a meaning, the science of language will have to be grouped among those other sciences which deal with the history of human development. The same difficulty meets us again in the case of geology, which traces the history of the earth, and if with Prof. Whitney we prefer to regard the science of language as a historical science, while we call geology a physical science, it is because the element of mind enters more largely into the one, and the element of matter into the other. The laws which govern matter remain always the same; those which govern thought and life are modified by a process of internal development.

The science of language, otherwise called glotology or linguistic science, should, strictly speaking, be distinguished from comparative philology. The latter, by comparing words and grammatical forms within separate groups of languages, and thereby ascertaining the nature of these several groups and the laws which govern their growth and formation, provides the materials for the science of language. This takes the results obtained by comparative philology in the various species and genera or families of speech, and with the help of the comparative method determines from them the laws of speech generally. Inasmuch as we have to compare phenomena belonging not only to the same period, but also to different periods in the history of language, that part of linguistic research which is not purely phonological has to assume a historical character, so that to discover the causes of the phenomena is to explain their origin and process of growth. Now the phenomena of language are words and sentences, phonetic utterances, that is, which are or have been significant.

Perhaps the most important result of the science of language has been the demonstration that even language, even those "winged words" over which men once fancied they had the most complete control, are as much subject

to the action of undeviating laws as the forces and atoms of material nature. We now know that what might seem at first sight the most arbitrary of all things, the phonetic change undergone by words in their passage from one dialect to another, is yet under the control of laws which have been discovered and formulated, and which act, unless interfered with by other laws, with unbroken regularity. The old haphazard guesses which once passed for etymologies are now impossible; given a certain word in Greek or Latin and its phonetic analogue in the other branches of the Aryan family can be determined with certainty. The most plausible derivations, such as that which would connect the Greek *καλέω* and the English *call*, have had to be given up, and the rule has been laid down that if two words in two allied languages exactly resemble one another, we may safely conclude that there is no connection between them.

The reason why the laws of language can be determined with such precision is that language is a social product, at once the creator and the creation of human society. Language exists for the sake of intercommunication; it is not what the individual man wishes to be significant that is so, but what the whole community, by a sort of unconscious agreement, determines to be so. Consequently, the arbitrary caprices of the individual have no influence upon the general character of speech. At the most, the individual can do no more than bring some word or phrase into fashion; all his efforts would not avail to change the phonology, structure, or grammar of a single tongue. Hence it is that the records of speech reflect the ideas and knowledge of society at each successive epoch of its growth, just as surely as the fossil records of the rocks preserve the past history of our globe. In tracing the growth and history of language we are really tracing the growth and history of society and of human development. The science of language thus becomes of the highest value in testing the various theories that have been formed respecting the early condition and education of mankind. It is the only key which will unlock the secrets of the prehistoric past of society with scientific certainty. Thus it bears unequivocal testimony to the belief that the history of humanity has been on the whole a progress and not a retrogression. The further back we penetrate into the records of speech the more childlike and barbarous is the society that left them seen to be. The words that came to represent moral and religious ideas originally had a purely sensuous meaning; there was a time when abstracts of any sort did not exist; and we even have faint glimpses of a period when men were painfully striving to create a language by the help of onomatopœia, and of a still earlier period when language as such was not yet formed. Equally unequivocal is the testimony borne by the science of language to the antiquity of man. The three causes of change in language—phonetic decay, the desire of emphasis, and the influence of analogy—are very slow in their action wherever society is sufficiently compact and settled to allow us to speak of its several forms of speech as dialects of the same family; and yet the oldest monuments of language to which we can appeal, whether in Egypt, in Babylonia, in Assyria, or even in that parent-Aryan which it is one of the triumphs of comparative

philology to have restored by a comparison of its derived languages, are all, linguistically speaking, late, and imply untold ages of previous development. Ethnologists, however, must remember that the science of language does not pretend to occupy their own special province. Language is a social product; it can tell us therefore nothing of races, only of communities. Members of the same race may speak unallied languages and members of unallied races may speak the same language; identity of speech is a test of social contact, not of race. Comparative philology can throw no light on the physical, as opposed to the mental and moral, history of man; that task must be left to other sciences.

One of the chief elements in the mental and moral history of man is the history of his religious ideas, and under the guidance of a scientific study of language this has been to a considerable extent cleared up by comparative mythology. The original meaning of the terms and phrases which embodied the earliest attempts to explain the phenomena of nature came to be forgotten with the increase of knowledge; a new signification was put into them and an imaginary fairy-world built upon the misunderstood word. The term whereby the primitive savage had endeavoured at once to explain the movements of the sun by endowing it with human attributes, and to express his own intuitions of the supernatural, became an Apollo or a Phaethon to whom the shrine was made or the legend recited. The words in which men have, as it were, photographed their religious convictions in different ages and in different parts of the world are an enduring record of the convictions themselves. But the words must be interpreted before the record can be read, and the key to the interpretation is in the hands of the science of language.

The science of language, however, has a practical as well as a purely theoretical interest. The practical object at which it aims is the creation of a universal language, one, that is, which may serve as the medium of communication between civilised communities throughout the whole world. Another object is the reform of English spelling, at present the despair of teachers and pupils. The spelling of a language ought to represent its pronunciation; our English spelling is a disgrace to a civilised community, a bar to a scientific appreciation of language, a hindrance to acquiring a conversational knowledge of foreign tongues, a cause of wasted time and brains in education, and a fruitful source of pseudo-etymologies. If comparative philology effect this reform and nothing else it will have sufficiently vindicated its practical utility. Equally important is the reform which it urges in the matter of classical education. The method of nature and of science is to proceed from the known to the unknown; this is reversed in our ordinary system of education which begins with the dead languages and ends with one or two living ones. By breaking down the monopoly of the two classical tongues and demonstrating that for purely linguistic purposes the modern languages of Europe are of greater importance, the science of language is doing a good work. In the study of the classical languages themselves it has effected a revolution. By explaining the nature and reason of their grammatical forms and rules it has lightened the burden of the learner, since to understand is to remember.

But we must not forget that the science of language is still a young science. Its followers are still engaged in laying its foundations and testing their strength. The problems that await solution are numerous and important. So far as our evidence goes at present, it tends to show that the languages of the world have sprung from an infinite number of separate sources, but it remains to be seen whether future discoveries will not reverse this conclusion. Then, again, there is the question of roots. All comparative philologists admit that roots are the ultimate elements into which language can be decomposed, but it is still a question whether the roots discovered by the grammarian once formed a spoken language, or whether they are but grammatical figments which are the best representatives we can obtain of the early condition of speech. Equally disputed is the question whether the different classes of language—inflectional, agglutinative, polysynthetic, and isolating—are to be regarded as constituting separate streams of linguistic development from the first, or a single stream which has branched out into separate ones. It is unquestionable that a large part of flection can be shown to have had an agglutinative origin, it is also unquestionable that the phenomena of isolation are to be met with in the inflectional languages, and the phenomena of flection in the isolating languages; but it is asked whether this would have been possible if each class had not had a definite tendency to flection or isolation from its starting—a standard, that is, to which all foreign elements introduced into the language were made to conform. Such are some of the questions which still remain to be answered; and if we are to judge from the rapid progress already made by the science of language, the answers will not be long in coming.

A. H. SAYCE

OUR BOOK SHELF

Rudiments of Geology. By Samuel Sharp, F.S.A., F.G.S. Second Edition. (London: Edward Stanford, 1876.)

THE author of this little manual, which is designed for the use of schools and junior students, has evidently taken considerable pains to make his work fairly represent the existing state of geological knowledge. He has, moreover, succeeded in conveying in simple language an idea, not only of the conclusions attained, but of the processes of investigation and reasoning, followed by the geologist in his researches, and we regard the book as well adapted to introduce a beginner to the study of the science, and to prepare him for the profitable perusal of more extended treatises. As compared with some of the similar introductory text-books of the science, which have recently been published, Mr. Sharp's manual labours under the disadvantage of being somewhat inadequately illustrated, for we find in it only a few diagrams and no figures of fossils. This second edition, however, is certainly a considerable improvement upon the first, and the division of Physical Geology has received much more full and careful treatment; the extent of the additional matter being sufficient to increase the number of pages of the book from 126 to 204.

South Australia: its History, Resources, and Productions. Edited by William Marcus. Illustrated with photographs taken in the Colony. Published by authority of the Government of South Australia. (London: Sampson Low and Co., 1876.)

THE nature of this handsome volume may be learned from the fact that it has been prepared to accompany the speci-

mens of South Australian products and industries sent to the Philadelphia Exhibition. It contains a vast amount of the most useful information on nearly all matters connected with the colony, gives an excellent idea of its present condition, and is likely to be of great use to intending settlers. Mr. Marcus, who edits the volume, writes also one half of it, treating of the social, political, and industrial aspects of the colony. In a series of valuable appendices, Dr. Schomburgk treats of the flora of South Australia, Mr. Waterhouse of its fauna, Mr. J. B. Austen of mines and minerals, while Mr. Josiah Boothby contributes a statistical sketch of the colony, and Mr. Charles Todd treats of its observatory and meteorology. There are two very useful maps, while the illustrations are nearly all good and interesting.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.]

The Spelling of the Name "Papua"

I QUITE agree with Mr. Whitmee's objections to English orthography of foreign words (see NATURE, vol. xiv. p. 48), but in this case I intended to show at a glance to non-linguistic readers that the accent in the word Papua must be on the second syllable, and not on the first. The Germans write "Papua," and pronounce "Pápua" (as they pronounce "Mántua," "Pádúa," &c.). This being wrong, and fancying that in England the same mistake is often made, I wrote "Papooa," which leaves no uncertainty in respect to pronunciation. I confess that it would have been more convenient to retain "Papua," and remark in a note that the accent must be on the "u." In a linguistic work I should never have proposed "Papooa," but it cannot be supposed that every reader of NATURE knows what Marsden pointed out in 1812. In German I write "Pápua," and perhaps the same mode would be the most convenient in English. It is known that the French use "Papoua," the Dutch "Papoea," the Malay "Papuwhah." In these cases the pronunciation may not be questionable, as it is in German and English, if written "Papua."

The most interesting point in Mr. Whitmee's letter is, no doubt, the announcement of a comparative grammar and dictionary of all the principal Malayo-Polynesian dialects; and those interested in these studies will certainly be anxious to receive such a valuable increase to their knowledge.

Dresden, May 23

A. B. MEYER

New Zealand Prehistoric Skeleton

AMONG the "Notes" in NATURE, vol. xiii. p. 196, just come to hand, you give an extract from the Order Paper of the Legislative Council of New Zealand concerning the remains of a supposed "prehistoric man," regarding which a motion for an inquest was tabled by Mr. Walter Mantell. As you correctly report, this skeleton was excavated under my direction in the so-called Moa-bone Point Cave, but it was not found in the lower beds containing Moa-bones, but in a much more recent formation, and to which I assigned a comparatively modern date.

You state that "I hold strongly to the palæolithic age of the deposits," but I am at a loss to conceive what ground you have for such an assertion, and as I can only conclude that you received your information direct from New Zealand, I beg to forward you herewith for your perusal a copy of my paper reporting the excavations and my views thereupon.

With regard to the motion itself, which was treated throughout the colony as a joke, it is sufficient to state that Mr. Walter Mantell is the recognised jester of the Legislative Council, and that even science does not escape his attempted witticisms. I may add that the Hon. Dr. Pollen, the Premier of the Colony, also treated the motion as a joke, and offered Mr. Mantell the office of coroner for the proposed investigation.

Although Mr. W. Mantell, F.G.S., stated, when speaking on his motion (see Hansard, 1875, p. 548), that "he gloried in the fact that he was not a scientific man, and he did hope he would be able to go to his grave without incurring that disgrace;" never-

theless, he is known to have his pet theories about the antiquity of the Moa, and is very impatient of any contradiction.

I have thought it right to offer this explanation in order to prevent your readers being misled on a subject of considerable scientific interest.

JULIUS VON HAAST
Canterbury Museum, Christchurch, N.Z., March 14

Visibility of the Satellites of Uranus

THE question of the visibility of these satellites in telescopes of moderate dimensions has lately excited considerable attention, but it does not appear that this question can be settled by any amount of verbal discussion. I take the liberty, therefore, to propose two test objects by means of which any one can, I think, satisfy himself whether he can see these satellites or not.

1. The companion of Regulus, north, preceding, and distant about three minutes of arc, has itself a small companion, which was discovered by the late Prof. Winlock. Any one who can see this small companion may be certain that he can observe the two outer satellites of Uranus and the satellite of Neptune.

2. The star of fifth magnitude, A Leonis, has a companion discovered at the Naval Observatory by Mr. G. Anderson. Any one who can observe this companion can, I think, see the two inner satellites of Uranus when at their elongations.

Of course in the case of such faint objects very much depends on the condition of the atmosphere, but the above tests are very nearly correct.

A. A. HALL

Washington, May 14

Protective Resemblance in the Sloths

IN a note upon the above subject, dated December 29, 1875, which appeared in vol. xiii. p. 187 of NATURE, I omitted to quote a passage from a letter written by Dr. Berthold Seemann to the late Dr. J. E. Gray (dated April 1, 1871), with regard to a specimen of *Arctophthacus*, of a well-marked green colour, obtained by the former naturalist in Nicaragua. Of this Sloth he says, *inter alia*:—"It should be borne in mind that it has almost exactly the same greyish-green colour as *Tillandsia usneoides*, the so-called 'vegetable horsehair' common in the district; and if it could be shown that it frequented trees covered with that plant (a point I hope to ascertain during my next visit in June next), there would be a curious case of mimicry between this Sloth's hair and the *Tillandsia*, and a good reason why so few of these sloths are seen." (Note on the species of *Bradypodidae* in the British Museum, by Dr. J. E. Gray, F.R.S., *Proc. Zool. Soc.*, May 2, 1871.) It would be interesting to know whether Dr. Seemann succeeded in solving this question; I am, however, not aware of any later reference made by him to this subject.

I here take the opportunity of correcting two misprints in my former letter, both of them in the Latin quotations, viz., "cum" for "eum," after the word "velleri," in the first, and "coque" instead of "eoque" after the word "possint," near the end of the second passage.

J. C. GALTON

OUR ASTRONOMICAL COLUMN

THE SECONDARY LIGHT OF VENUS.—During the next few weeks a very favourable opportunity will be afforded to observers in these latitudes for further examination of the planet Venus, with the view to a satisfactory solution of what must yet be regarded as a *questio vexata*—the visibility of that part of the disc, which is unilluminated by the sun, as the planet approaches or recedes from the inferior conjunction.

The subject is treated in detail in a communication to the Bohemian Academy of Sciences, from Prof. Safarik of Prague, entitled "Über die Sichtbarkeit der dunklen Halbkugel des Planeten Venus," which appears in *Sitzungsberichte der k. böhmischen Gesellschaft der Wissenschaften*, July 18, 1873. The author has collected together the many scattered observations extending over upwards of one hundred and fifty years, and presents also an outline of the various explanations which have been put forward.

The earliest mention of the faint illumination of the dark side of Venus is by Derham, in a passage in his *Astro-Theology*, to which attention was first directed by Arago. Derham refers to the visibility of the obscure part of the globe "by the aid of a light of a somewhat dull and ruddy colour." The observation is not dated, but appears to have been prior to the year 1714. A friend of Derham's is also stated to have perceived the same illumination very distinctly.

The next observations are by Christfried Kirch, second astronomer of the Berlin Academy of Sciences, June 7, 1721, and March 8, 1726, and were found in his original papers and printed in *Ast. Nach.* No. 1586. The image on the first occasion was tremulous, but though he could hardly credit his vision, he appeared to discern the dark side of the planet. In 1726 he remarked that the dark periphery seemed to belong to a smaller circle than the illuminated one. Kirch observed with telescopes of sixteen and twenty-six feet focal length, powers 80 and 100. Two other persons confirmed his observation in 1726.

The next observation in order of date, was found by Olbers, in "Observationes Veneris Grypswaldensis," cited by Schröter in his observations of the great comet of 1807. It was made by Andreas Mayer, Professor of Mathematics at Greiswald: on October 20, 1759, he observed the meridian passage of the planet, then at a south declination of $21\frac{1}{2}^{\circ}$, with a six-foot transit instrument by Bird, power not much over 50, and has the remark—"Etsi pars lucida Veneris tenuis admodum erat, nihilominus integer discus apparuit, instar lunæ crescentis quæ acceptum a terra lumen reflectit." As Prof. Safarik justly observes, considering the circumstances under which Mayer's observation was made with the planet only 10° from the sun, and not more than 14° above the horizon, the phenomenon on this occasion must have had a most unusual intensity.

It does not appear that Sir W. Herschel at any time perceived the secondary light of Venus, though he remarked the extension of the horns beyond a semi-circle.

Von Hahn, at Remplin, in Mecklenberg, the possessor of excellent telescopes by Dollond and Herschel, was fortunate in viewing the dark side of Venus on frequent occasions during the spring and summer of the year 1793, and he is considered by Safarik to have witnessed the illumination of this part of the disk under more varying conditions than any other observer. The light is described as grey verging upon brown. Von Hahn's observations were made with various instruments and at different hours of the day.

Schröter, at Lilienthal, on several occasions between the years 1784 and 1795, had remarked in full sunshine the extension of the horns of the crescent many degrees beyond the semicircle, the borders of the dark hemisphere being faintly illuminated with a dusky grey light; but on February 14, 1806, at 7 P.M., he saw for the first time the whole of the dark side, as he expressed it, "in äusserst mattem dunkeln Lichte." The sharply-defined contour had an ash-coloured light; the surface was more dimly illuminated. Schröter, in recording this observation, expresses his surprise that during the many years he had observed the planet, part of the time with his 27-feet reflector, with the full aperture of 20 inches, he had not previously perceived the whole of the dark side, but he was satisfied there was no illusion. At this time one-eighth of the diameter of Venus, about $48''$, was fully illuminated, the planet casting a very sensible shadow.

Harding, observing at Göttingen on January 24 of the same year, with a 10-feet Herschelian reflector, power 84, and full aperture of 9 inches, saw the whole dark side of Venus shining with a pale ash-coloured light, very distinctly perceived against the dark ground of the sky. The appearance was too evident to allow of the suspicion of an illusion; it was the same in all parts of the field of

view, and under various magnifying powers. Altogether the phenomenon was as distinct as in the case of our moon. On February 3, 16, and 21 it was not seen, but on the evening of February 28, it was again prominently visible to Harding; the illumination was now of a reddish grey, "like that of the moon in a total eclipse." Yet on the same evening Schröter looked in vain for the phenomenon at Lilienthal, showing how cautiously negative evidence should be received.

Observations of the secondary light were made by Pastorff in 1822 and by Gruithuisen in 1825.

The *Monthly Notices* of the Royal Astronomical Society contain many observations since the year 1842 by Messrs. Berry, Browning, Guthrie, Langdon, Noble, Prince, and others. Mr. Prince had favourable views of the illumination of the dark side in September 1863. Capt. Noble's observations, as remarked by Prof. Winnecke in his notice of Prof. Safarik's memoir, do not appear to refer to the secondary light as it has been perceived by other observers. He mentions that the hemisphere unilluminated by the sun has to him "always appeared distinctly and positively darker than the background upon which it was projected," a statement which certainly gives the observations a distinctive character.

There are also observations of the secondary light by Lyman, at Yale College in 1867, and about the same time by Safarik at Prague, and in August, 1871, more decidedly. In September of the latter year the whole disk of Venus was seen by Prof. Winnecke as described in *Ast. Nach.*, No. 1863. This astronomer has since stated that notwithstanding he has observed the planet many hundred times during the last twenty-four years, he has only succeeded in perceiving this remarkable illumination of the dark side on two occasions; and it should be added that Dawes, Mädler, and other eminent observers, have never detected it. We shall revert to this subject next week.

THE OBSERVATORY AT ATHENS.—The death is announced of Baron Simon von Sina, son of the founder of the Observatory at Athens, which has been successively under the direction of M. Bouris and Herr Julius Schmidt. The deceased Baron is mentioned as a liberal patron of this establishment, though not himself engaged in scientific pursuits, and Herr Schmidt writes doubtfully of the future of the Observatory. Every astronomer will entertain the hope that this most laborious and successful observer—distinguished not only by his great work upon the moon, but for his numerous discoveries and observations of variable stars, his long and important series of observations of comets, of short period and otherwise, in which he has made excellent use of the advantages of his southern position, and many other valuable contributions to observational astronomy—may continue to hold, under favourable auspices, the direction of an establishment which his exertions have made so honourably known in the astronomical world.

THE LOAN COLLECTION CONFERENCES

OWING to the pressure on our space this week, we can only refer briefly to what has been done since our last notice at the Conferences in connection with the Loan Collection. We give, however, in another part of the paper the presidential addresses of Dr. J. Burdon Sanderson, F.R.S., in the Section of Biology, and of Mr. John Evans, F.R.S., in the comprehensive Section of Physical Geography, Geology, &c. We hope in early numbers to be able to give at some length the principal papers which have been read in the various sections.

On Thursday last the concluding meeting in the Section of Mechanics was held, when the following papers were read:—"On Prime Movers," by Mr. Bramwell, F.R.S.; "The Construction of Furnaces," by Mr. Hackney; "A History of Electric Telegraphs," by Mr. Preece.

The first meeting in the Section of Biology was held on Friday, when the papers of which we gave a list in our last week's notice were read. This Section met also on Monday, when the following papers were read:—

Dr. Royston-Pigott, F.R.S., on a "Microscope with Complex Adjustments, Searcher, and Oblique Condenser Apparatus;" Prof. Rutherford, F.R.S., "On a Freezing Microtome;" Prof. Flower, F.R.S., "On the Osteological Preparations exhibited by the Royal College of Surgeons;" Herr Prof. Dr. Donders, "Ophthalmological Apparatus;" Dr. M'Kendrick, "Acoustical Instruments;" Prof. Yeo, M.D., and Dr. Urban Pritchard, "On Microtomes."

On Tuesday the first meeting in the Section of Physical Geography, Geology, Mineralogy, and Meteorology, was held, when, in addition to the President's Address, the following papers were read:—

Mr. R. H. Scott, F.R.S., "Meteorological Instruments in the Loan Collection;" Mr. G. J. Symons, "The Measurement of the Rainfall;" Dr. R. J. Maon, "Lightning Conductors;" M. le Professeur A. Daubrée, "La Géologie Synthétique;" Mr. J. E. H. Gordon gave an explanation of his Anemometer; Mr. C. O. F. Cator "On Anemometers;" Prof. von Oettingen gave a description of his Anemometer; Dr. R. J. Mann, "Lowne's Series of Anemometers;" Mr. John Evans, F.R.S., "Dalton's Percolation Gauge."

This Section meets again to-day and to-morrow, for which days the following programme has been drawn up:—For to-day.—Capt. Baron Ferdinand von Wrangell, "On Self-registering Tide-gauges;" Lieut. Cameron, R.N., "Physical Geography of South Tropical Africa;" Major Anderson, R.E., "Maps of Palestine;" Col. Walker, R.E., or Col. Montgomerie, R.E., "Discoveries in Tibet;" Mr. Francis Galton, F.R.S., "On Means of Combining Various Data in Maps and Diagrams;" Capt. Evans, R.N., C.B., F.R.S., Hydrographer of the Navy, "Hydrography, its present Aspects;" Capt. J. E. Davis, R.N., "The various forms of Sounding Apparatus used by Her Majesty's Ships in ascertaining the depth of the ocean, and the nature of its bottom;" Staff-Commander E. W. Creak, R.N., "Nautical Magnetic Surveys;" Prof. Roscoe, F.R.S., "Automatic Light Registering Apparatus." For to-morrow.—Prof. Ramsay, F.R.S., "The Origin and Progress of the Geological Survey of the British Isles, and the method on which it is conducted;" Mr. W. Topley, F.G.S., "The Sub-Wealden Boring;" Mr. C. E. de Rance, F.G.S., "Sketch of the Geology of the known Arctic Regions;" Mr. W. Galloway, "Colliery Explosions;" Prof. Baron von Ettingshausen, "The Tertiary Origin of the actual Flora;" Mr. J. S. Gardner, F.G.S., "The Tertiary Floras;" M. des Cloiseaux, Membre de l'Institut, "L'emploi des propriétés biréfringentes à la détermination des cristaux;" Mr. Walter Rowley, F.G.S., "Description of his Transit Theodolite for Mine Surveying, and other purposes;" The Rev. Nicholas Brady, M.A., "Desirability of a Uniform International Notation for Crystallography."

This will conclude these Conferences, which are admitted on all hands to have been a great success and to have added very much to the practical value of the collection. The popular expositions we referred to last week have been carried on with success, and apparatus may now be minutely inspected on Wednesdays, Thursdays, and Fridays, on application to the Director of the South Kensington Museum on forms provided for the purpose.

As we intimated last week, the Science and Art Department are organising a series of popular lectures in connection with the Loan Collection, to be given on the evenings of the free days—Mondays, Tuesdays, and Saturdays. We believe that the first of these lectures will be given on Saturday by Prof. Roscoe, F.R.S., on Dalton's Apparatus, and what he did with it."

THE CRUISE OF THE "CHALLENGER"

HER Majesty's ship *Challenger* was despatched towards the close of the year 1872, round the world, on a surveying and discovery expedition of a very special character. Her principal object as laid down in her instructions was to determine, as far as possible, the physical and biological conditions of the great ocean basins, the Atlantic, the Southern Sea, and the Pacific. The voyage was undertaken, as we have already said in our short biographical sketch of Prof. Wyville Thomson, chiefly in consequence of remarkable discoveries made during the four previous years, in short cruises, in H.M. gunboats *Lightning* and *Porcupine*, liberally detached by the Admiralty, at the instance of the Royal Society, for scientific research, under the direction of Dr. Carpenter, C.B., F.R.S., Mr. Gwyn Jeffreys, F.R.S., and Prof. Wyville Thomson, F.R.S. These discoveries seemed so important, not merely in a purely scientific point of view, but also in their bearings on ocean-telegraphy, that the Government determined to follow them up by a deep-sea survey on a more extended scale.

The *Challenger* was fitted out under the superintendence of Admiral Richards, C.B., F.R.S., at that time Hydrographer to the Navy, and in addition to a full naval surveying staff under the immediate superintendence of Capt. Nares, F.R.S., who was afterwards recalled to take command of the Arctic Expedition, a civilian staff of specialists in Natural Science and Chemistry was attached under the direction of Prof. Wyville Thomson.

The expedition, although by no means sensational, has been thoroughly successful. The *Challenger* has steadily traversed a track of 69,000 miles, and during her absence of three years and a half from England has established 362 observing stations, at all of which the depth has been ascertained with the greatest possible accuracy, and at nearly all the bottom temperature has been taken, a sample of the bottom water has been brought up for physical examination and chemical analysis, a sufficient specimen of the bottom has been procured, and the trawl or dredge has been lowered to ascertain the nature of the fauna. At most of these stations serial soundings have been taken with specially devised instruments to ascertain by the determinations of intermediate temperatures and by the analysis and physical examination of samples of water from intermediate depths, the directions and rate of movement of deep-sea currents.

The original arrangements for the cruise have worked in every way smoothly; the weather throughout has been on the whole favourable; under the careful management of Staff-Commander Tizard not a shadow of mishap has ever befallen the ship; there has been a perfect *bon accord* between the naval men and the civilians; all the appliances for carrying on the different operations, liberally supplied at first, were renewed by the officers of the Hydrographic Department of the Admiralty with the utmost liberality and precision.

Two events only have seriously affected the interests of the expedition, one, the sad death at sea of Dr. v. Willemoes-Suhm, one of the ablest of the naturalists on the civilian staff, the other the recall of Capt. Nares; for although Capt. Frank T. Thomson, who joined the *Challenger* from the *Modeste*, did everything in his power to fill his place, Capt. Nares, from his previous scientific training was so eminently fitted to lead such an expedition that his withdrawal in the middle of it was severely felt.

Leaving England on Saturday the 21st of December, 1872, some rough weather was encountered as the *Challenger* stood for the mouth of the Channel, and crossed the Bay of Biscay.

1873

On the 3rd of January, 1873, passing Cape Roca and the lovely heights of Cintra, she was quietly steaming

up the Tagus, and came to anchor off Lisbon. Lisbon was left on the 12th, and a series of dredgings and examinations of bottom temperatures were made off Cape St. Vincent in from 400 to 1,200 fathoms. Gibraltar was reached on the 18th, and left on the 26th. The weather was now pretty moderate, and there was a very fairly successful week's sounding, trawling, dredging, and taking temperatures between the Rock and Madeira, which latter station was reached on the 3rd of February. Some of the dredgings made at this period appear to have been most successful, and a number of strange new forms of animal life were found, among these a fine new species of Venus's Flower-basket (*Euplectella suberea*), Fig. 1, a Bryozoon (*Naresia cyathus*), (see figure, vol. vii. p. 387) of singular beauty, which was dedicated to Capt. Nares, some wondrous forms of Sea-Urchins and Lily-Stars, and specimens of a species of "Clustered Sea-polye," since described by Dr. Kölcker under the name of *Umbellularia thomsoni*, an animal of great scientific interest.

But two days were spent at Madeira, and the *Challenger* was off Teneriffe early on the morning of the 7th, too early to attempt the ascent of the famous Peak, and rather too early for natural history work, still collections, both geological and zoological, were made, a series of dredgings were successfully tried between Teneriffe and Palma, past Gomera and Hierro, and a great number of observations as to temperature were taken. In the matter of meteorological observations we may mention that the officers of the Expedition seem to have excelled; the number of observations amounted during the first twelve months of the cruise to upwards of 50,000. Very considerable depths were found off the Canary Islands, extending sometimes to upwards of 1,700 fathoms; but the greatest depth found in this part of the Atlantic was one of 2,500 fathoms off Cape St. Vincent.

At Teneriffe the regular work of the Expedition may be said to have commenced. All the time between leaving home and arriving off the Canaries had been more or less devoted to getting the varied machinery into order, and in settling the direction and scope of the parts the members of the civilian staff had to play; so at Santa Cruz the old journals were closed, and the numbering of the stations and the other entries were commenced afresh, with some alterations the result of additional experience. A section was now to be carried right across the Atlantic from Teneriffe to Sombbrero, the latter a little speck of an island north-west of Anguilla, and one of the group of Virgin Islands, themselves a portion of the West Indies. Sombbrero was reached on the 15th of March, just a month from the time of leaving Santa Cruz. The distance between the two islands is about 2,700 miles, and along this line twenty-three stations were selected, at which most careful observations were made as to depth, condition, and temperature of bottom. During one of these dredgings, and at a depth of 1,500 fathoms, several specimens of a magnificent sponge belonging to the Hexactinellidæ were found attached to the branches of an Isis-like coral, and nestling among the fibres of the sponge were star-fishes, annelids, and Polyzoa. Often during this cruise, when the weather was calm and hot, the tow-net was used on the surface. It would seem that the greater number of the pelagic forms retire during the heat of the day to the depth of a few fathoms, and come up in the cool of the evening and in the morning, and in some cases in the night. The larger phosphorescent animals were frequently abundant during the night round the ship and in its wake, while none would be taken during the day. One day (the 26th of February), the morning being bright and clear and the swell not heavy, the ship being some 1,600 miles from Sombbrero, and in lat. 23° 23' N., long. 32° 56' W., the sounding-line indicated a depth of 3,150 fathoms, and the bottom was found to consist of a perfectly smooth red clay, containing scarcely a trace of organic matter. This was the greatest depth as yet met with, and the material from the bottom

was something quite novel to the explorers. At the mean maximum depth of some 2,200 fathoms the ooze was one vast mass of the calcareous shells of foraminifera, but as the soundings got deeper the ooze began to assume a darker tint, and showed, on analysis, a continually decreasing quantity of calcareous matter. Now in this red ooze almost no calcareous forms were to be met with, and it was of extreme fineness, remaining for a long time in suspension in water, and proving on analysis to be almost pure clay, a silicate of alumina and the sesquioxide of

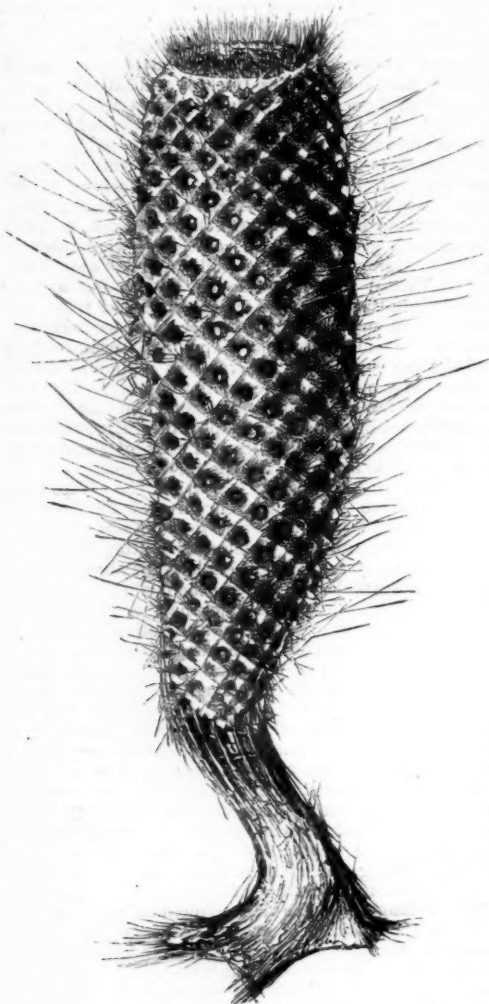


FIG. 1.—*Euplectella suberea*.

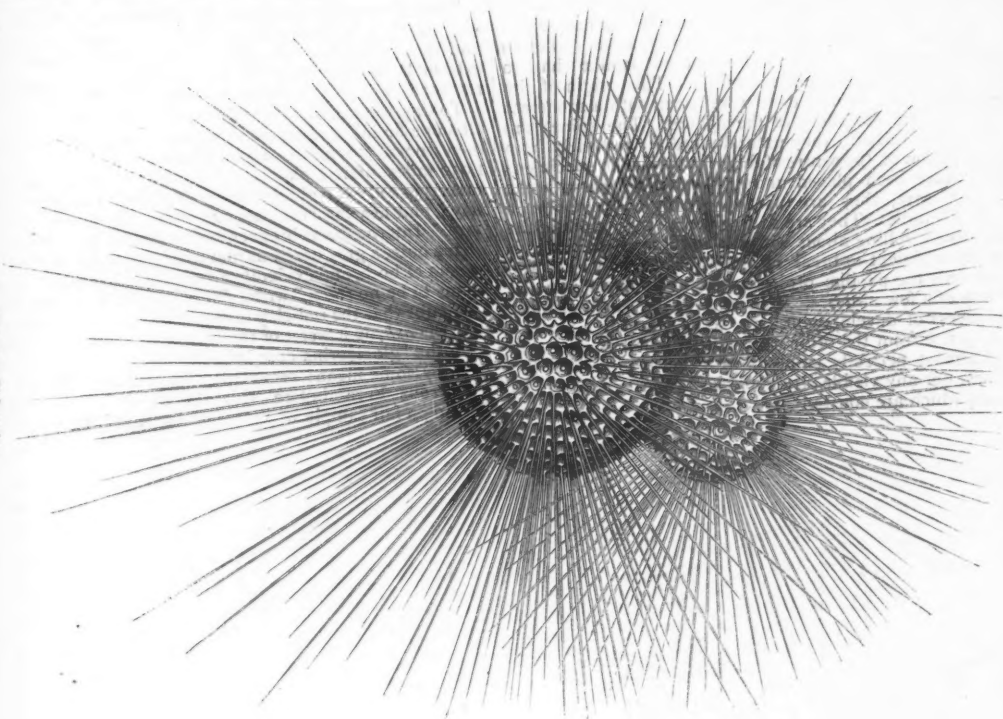
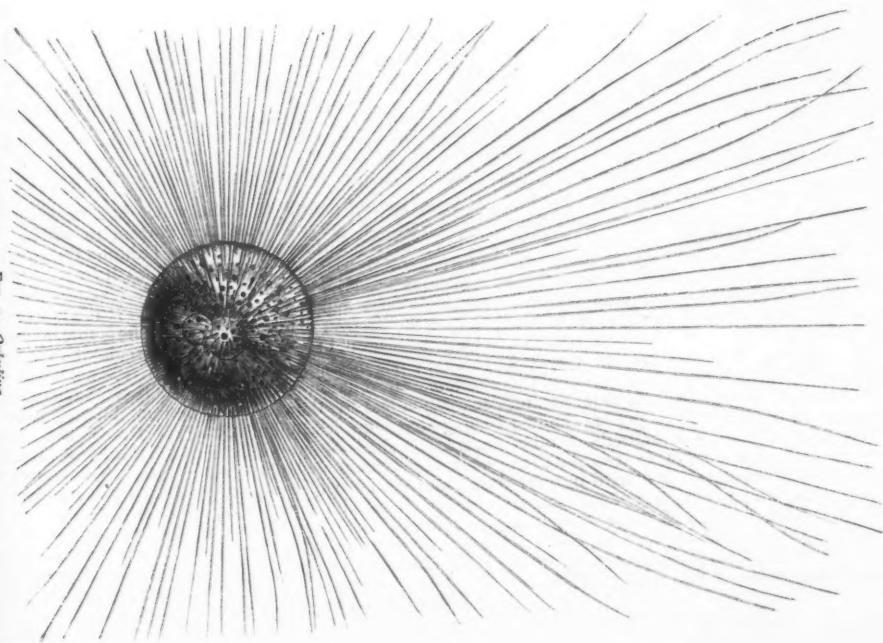
iron, with a small quantity of manganese; and at this depth there appeared to be an absence of animal life.

Prof. Wyville Thomson considers it as quite proved that all the materials for such deposits, with the exception of the remains of those animals which are now known to live at the bottom at almost all depths, are derived from the surface; and considering the very enormous extension of the calcareous ooze, it becomes important to know something of the minute foraminifera that produce it. In all seas, from the equator almost to the polar ice, the surface-water contains *Globigerina*. They are more abun-

dant and of a larger size in warm seas; several varieties attaining a large size, and presenting marked varietal characters, are found in the intertropical area of the Atlantic. In the latitude of Kerguelen they are less numerous and smaller, while further south they are still more dwarfed, and only one variety, the typical *Globigerina bulloides*, is represented. The living *Globigerina* from the tow-net are singularly different in appearance from the dead shells we find at the bottom (Fig. 2). The shell is clear and transparent, and each of the pores which penetrate it is surrounded by a raised crest, the crest round adjacent pores coalescing into a roughly hexagonal network, so that the pore appears to lie at the bottom of a hexagonal pit. At each angle of this hexagon the crest gives off a delicate flexible calcareous spine, which is sometimes four or five times the diameter of the shell in length. The spines radiate symmetrically from the direction of the centre of each chamber of the cell, and the sheaves of long transparent needles, crossing one another in different directions, have a very beautiful effect. The smaller inner chambers of the shell are entirely filled with an orange-yellow granular sarcode; and the large terminal chamber usually contains only a small irregular mass, or two or three small masses run together, of the same yellow sarcode stuck against one side, the remainder of the chamber being empty. No definite arrangement, and no approach to structure, was observed in the sarcode; and no differentiation, with the exception of bright-yellow oil-globules, very much like those found in some of the Radiolarians, which are scattered apparently irregularly in the sarcode, and usually one very definite patch of a clearer appearance than the general mass coloured vividly with a carmine solution. The presence of scattered particles of bioplasm was indicated by minute spots here and there throughout the whole substance which received the dye.

When the living *Globigerina* is examined under very favourable circumstances, that is to say, when it can be at once placed under a tolerably high power of the microscope in fresh still sea-water, the sarcodic contents of the chambers may be seen to exude gradually through the pores of the shell, and spread out until they form a kind of flocculent fringe round the shell, filling up the spaces among the roots of the spines and rising up a little way along their length. This external coating of sarcode is rendered very visible by the oil-globules, which are oval, and filled with intensely-coloured secondary globules, and are drawn along by the sarcode, and may be seen, with a little care, following its spreading or contracting movements. At the same time an infinitely delicate sheath of sarcode containing minute transparent granules, but no oil granules, rises on each of the spines to its extremity, and may be seen creeping up one side and down the other of the spine with the peculiar flowing movement with which we are so familiar in the pseudopodia of *Gromia* and of the Radiolarians. If the cell in which the *Globigerina* is floating receive a sudden shock, or if a drop of some irritating fluid be added to the water, the whole mass of sarcode retreats into the shell with great rapidity, drawing the oil-globules along with it, and the outline of the surface of the shell and of the hair-like spines is left as sharp as before the exodus of the sarcode.

There is still a good deal of obscurity about the nature of *Orbulina universa*, an organism which occurs in some places in large proportion in the globigerina ooze. The shell of *Orbulina* (Fig. 3) is spherical, usually about .5 mm. in diameter, but it is found of all smaller sizes. The texture of the mature shell resembles closely that of *Globigerina*, but it differs in some important particulars. The pores are markedly of two different sizes, the larger about four times the area of the smaller. The larger pores are the less numerous; they are scattered over the surface of the shell without any appearance of regularity; the smaller pores occupy the spaces between the larger. The

FIG. 2.—*Chelasterium*.FIG. 3.—*Oronotus*.

crests between the pores are much less regular in *Orbulina* than they are in *Globigerina*; and the spines, which are of great length and extreme tenuity, seem rather to arise abruptly from the top of scattered papillæ than to mark the intersections of the crests. This origin of the spines from the papillæ can be well seen with a moderate power on the periphery of the sphere. The spines are hollow and flexible; they naturally radiate regularly from the direction of the centre of the sphere; but in specimens which have been placed under the microscope with the greatest care, they are usually entangled together in twisted bundles. They are so fragile that the weight of the shell itself, rolling about with the motion of the ship, is usually sufficient to break off the whole of the spines and leave only the papillæ projecting from the surface in the course of a few minutes. In some examples, either those in process of development, or a series showing a varietal divergence from the ordinary type, the shell is very thin and almost perfectly smooth, with neither papillæ nor spines, nor any visible structure except the two classes of pores, which are constant.



FIG. 4.—Rhabdosphere.

Thomas, was carefully washed and subjected by Mr. Buchanan to the action of weak acid; and he found that there remained, after the carbonate of lime had been removed, about one per cent. of a reddish mud, consisting of silica, alumina, and the red oxide of iron. This experiment has been frequently repeated with different samples of 'globigerina ooze,' and always with the result that a small proportion of a red sediment remains, which possesses all the characters of the 'red clay.' I do not for a moment contend that the material of the 'red clay' exists in the form of the silicate of alumina and the peroxide of iron in the shells of living Foraminifera and Pteropods, or in the hard parts of animals of other classes. That certain inorganic salts other than the salts of lime exist in all animal tissues, soft and hard in a certain proportion, is undoubted; and I hazard the speculation that during the decomposition of these tissues in contact with sea-water and the sundry matters which it holds in solution and suspension, these salts may pass into the more stable compound of which the 'red clay' is composed."

On this voyage Mr. Buchanan found the remarkable

The Coccospheres and Rhabdospheres—these are suggested to be minute algæ forms—live on the surface, and sink to the bottom after death. Many of them are extremely beautiful, as will be seen from Figs. 4 and 5, representing two forms first discovered by Mr. Murray.

Taking the section from Teneriffe to Sombrero, first of all some 80 miles of volcanic mud and sand were passed; then some 350 miles of globigerina ooze; next about 1,050 miles of red clay; then again a rising ground for some 330 miles of globigerina ooze, a valley of 850 of red clay; and nearing land some 40 miles of the globigerina ooze. Intermediate between the red clay and the globigerina ooze, a grey ooze was met with, partaking of the characters of both, and evidently a transitional stage. "There seems to be no room," writes Prof. Wyville Thomson, "left for doubt that the red clay is essentially the insoluble residue, the ash, as it were, of the calcareous organisms which form the 'globigerina ooze,' after the calcareous matter has been by some means removed. An ordinary mixture of calcareous Foraminifera with the shells of Pteropods, forming a fair sample of 'globigerina ooze' from near St.

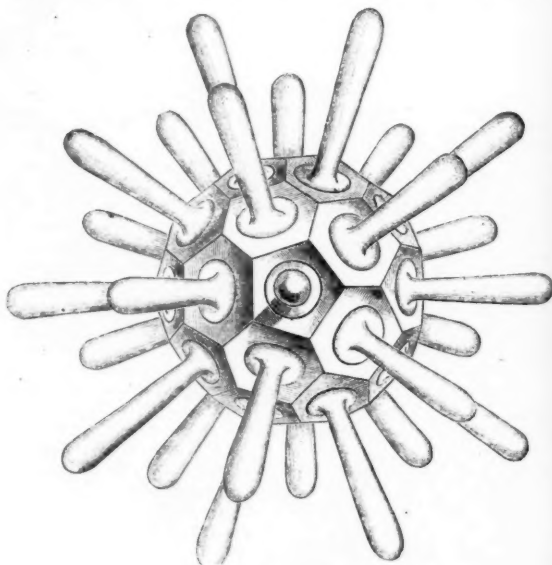


FIG. 5.—Rhabdosphere.

and unexpected result that the water has virtually the same specific gravity from the bottom to within 500 fathoms of the surface. From 500 fathoms the specific gravity rapidly rises till it usually attains its maximum at the surface. Nineteen dredgings were taken, and these yielded a large supply of animal forms. It is unfortunate that in the deepest haul of all, 3,150 fathoms, no living thing was brought up higher in the scale than a foraminifer; but this may be attributed to the nature of the bottom, an opinion borne out by the abundance, at scarcely a less depth, and on a bottom differing only in being somewhat less uniform, and containing sand-grains and a few shells of foraminifera, of tube-building annelids of a very common shallow water type. The crustacea do not appear to suffer from the peculiarity of the circumstances under which they live, either in development or in colour. The singular fact of the suppression of the eyes in certain cases is already well known. The Echinoderms and sponges which enter so largely into the fauna of the zone ending at 1,000 fathoms are not abundant at extreme depths.

The *Challenger* next anchored off the harbour of Char-

lotte Amalia, at St. Thomas, where a pleasant week was spent, and on the 25th of March she proceeded on her way to the Bermudas. On Monday the 26th, being then in lat. $19^{\circ} 41' N.$, long. $65^{\circ} 7' W.$, and nearly ninety miles north of St. Thomas, a sounding was made in the great depth of 3,950 fathoms, and a dredge was let down to see if it would prove serviceable; heaving-in commenced at 1.30, and the dredge came up at 5 P.M. with a considerable quantity of reddish-grey ooze. No animals were detected except a few small foraminifera with calcareous tests, and some considerably larger of the arenaceous type.

On the 4th of April she made her way through the intricate and dangerous "narrows" between the coral reefs, and by the evening was at anchor at Grassy Bay, Bermudas. A fortnight was spent at these Islands. Their geological structure was most carefully studied, and when the narrative of the cruise is published we may expect very valuable information as to the formation of the various forms

of limestone to be found on these islands. The principal islands are well wooded, but the great preponderance of the Bermudian Cedar (*Juniperus bermudiana*) gives a gloomy character to the woods, which in the annexed woodcut is somewhat relieved by the presence of some palm trees (Fig. 6). The Admiral's official residence, Clarence Hill, is situated on an inclosed little bay called Clarence Cove. The garden was rich with a luxuriant tropical vegetation of which the group of papau trees, *Carica papaya* (Fig. 7), will give some idea.

There is only one kind of rock in Bermudas. The islands consist from end to end of a white granular limestone, here and there becoming grey or slightly pink, usually soft and in some places friable, so that it can be broken down with the ferrule of an umbrella; but in some places, as on the shore at Hungry Bay, at Painter's Vale, and along the ridge between Harrington Sound and Castle Harbour, it is very hard and compact, almost crys-

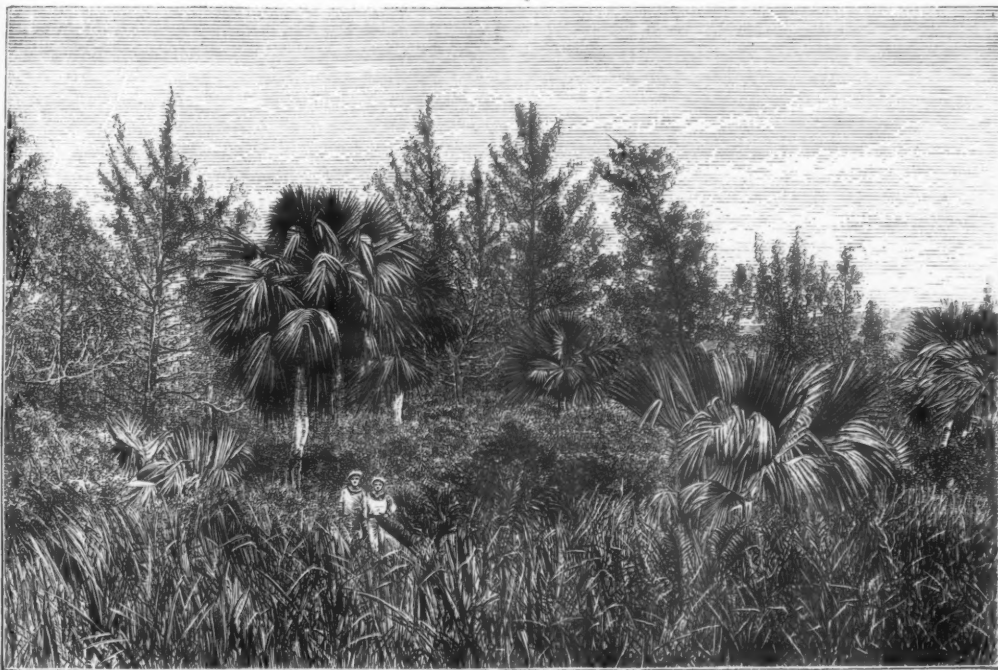


FIG. 6.—Swamp Vegetation, Bermudas.

tallies, and capable of taking a fair polish. This hard limestone is called on the island the "base rock," and is supposed to be older than the softer varieties and to lie under them, which is certainly not always the case. It makes an excellent building stone, and is quarried in various places by the engineers for military works (Fig. 8). The softer limestones are more frequently used for ordinary buildings. The stone is cut out of the quarry in rectangular blocks by means of a peculiarly constructed saw, and the blocks, at first soft, harden rapidly, like some of the white limestones of the Paris basin, on being exposed to the air.

Immense masses of fine coral sand surround the shores, being washed in by the sea. It is then caught at certain exposed points by the prevailing winds, and blown into sand-hills often forty to fifty feet in height. Sometimes these sand-masses form regular sand-glaciers. One of these was found at Elbow Bay on the southern shore of

the main island. The sand has entirely filled up a valley and is steadily progressing inland in a stream some five and twenty feet. It has, as will be seen in the woodcut (Fig. 9), partially overwhelmed a garden, and is still flowing slowly on. When the photograph from which the woodcut is copied was being taken, the owner of the garden was standing with his hands in his pockets, as is too much the habit of his race, contemplating the approach of the inexorable intruder. He had, as will be seen, made some attempt to stay its progress, by planting a line of oleanders and small cedars along the top of the slope, but this had been in vain.

The botanists of the expedition paid a good deal of attention to the flora of the island, and we may expect a lot of new forms among the minute algae found in the so-called freshwater ponds or lakes.

Bermudas was left on the 20th of April, and a section was carried out from the islands towards Sandy Hook,

and then south and west of Little George Bank and into Halifax on the 9th of May. In this run several soundings were taken at depths of from 2,600 to 2,800 fathoms. The bottom yielded chiefly grey ooze, and the course of the Gulf Stream was crossed. Staying a week at Halifax to recruit, the next section was made in almost a straight line from Halifax to Bermudas, which was reached on the 30th of May, nine important stations having been selected and examined on the way. A short time was passed at Bermudas, and the next section it was determined to make was one between lat. 35° and 40° to the Azores. Leaving Bermudas on the 12th of June the *Challenger* was

off Fayal on the 1st of July, having successfully made observations at seventeen stations *en route*. A small-pox epidemic having broken out at Fayal, it was not deemed prudent to land. San Miguel was visited, and the straits between it and Santa Maria were explored, and the *Challenger* on the 10th stood for Fauchal, reaching it on the 15th, having been now more than a month at sea. Having made two sections right across the Atlantic, all looked to enjoying a few days on land, but it was not to be so, for most unluckily a rather severe epidemic of small-pox had broken out at Madeira also shortly before, and Capt. Nares did not think it prudent to give



FIG. 7.—*Carica papaya*.

leave; accordingly on the 18th of July they commenced to make a section along the West Coast of Africa. It was the rainy season; each day would bring them nearer to the equator, and it was scarcely possible to look forward to other than disagreeable times. On the 19th they were off Palma Island, one of the Canaries; then they bore down on S. Antonio, one of the Cape Verd islands, and were at St. Vincent on the 27th of July.

The botany of this island, so noted in the old gazetteers for its wood, water, wild goats, turtles, and saltpetre, was carefully explored. As seen from the sea, the rocks presented a singular appearance, owing to the presence of a

thick incrustation at water-mark or masses of calcareous algae, which either follow the forms of the rocks or occur in rounded masses, their delicate tints of white, light pink, or cream colour considerably heightening the effect. These incrustations are frequently bored by *Lithodermus candigerus* and other molluscs, and small sponges and Polyzoa occupy the cavities between them and the rocks.

Leaving the Cape Verd Islands, on the 13th of August they were off the Bissagos Islands, and found bottom at a depth of 2,575 fathoms. Continuing to cruise along the coast, on the 14th they were west of the Loss Islands; on the 15th they passed Sierra Leone; on the 19th they

were off Cape Mesurado, still in depths of 2,500 fathoms; and on the 21st they had run as far along the Western Coast of Africa as they intended, being then off Cape Palmas, and the *Challenger's* course was shaped for St. Paul's Rocks. These rocks lie about 1° north of the equator, and in longitude $29^{\circ} 15' W.$, being about midway between the South American and African coasts. Although rising to a height of some 50 to 60 feet above the sea-level, yet they are mere rocks, not more than a quarter of a mile long. The sea deepens quickly in the vicinity of the rocks to depths of from 1,500 to 2,200 fathoms. The wash of the waves is such that even sea-weeds cannot retain their positions on the rocks.

Proceeding still in a south-west direction, the little group of islands called Fernando Noronha was reached on the 1st of September, and some days were spent exploring it. The group consists of a principal island about four miles long by three and a half broad, and several

smaller ones; it is situated in the Atlantic, in about lat. $3^{\circ} 58' S.$, long. $32^{\circ} 22' W.$, and about 200 miles from the nearest point of the American coast. The islands appear to be of volcanic origin; the peak on the northern side of the principal island rises to a height of 1,000 feet; it is a mass of bare rock, the summit of which is quite inaccessible. The cliffs are chiefly composed of columnar basalt. The sea-depth in the neighbourhood is from 1,000 to 2,000 fathoms. Trees abound on the higher parts of the island, and wondrous creepers cluster together in the branches of the trees. A species of *Cereus* was found by Mr. Mosely on the cliffs. Only one grass (*Optismenus colonus*) was found on the main island, but although shady, moist places occur about St. Michael's Mount, neither on this nor on the main island were any ferns, mosses, or hepaticæ found, and lichens were very scarce. Among the principal cultivated fruits are bananas and melons, the latter being very plentiful, and of a

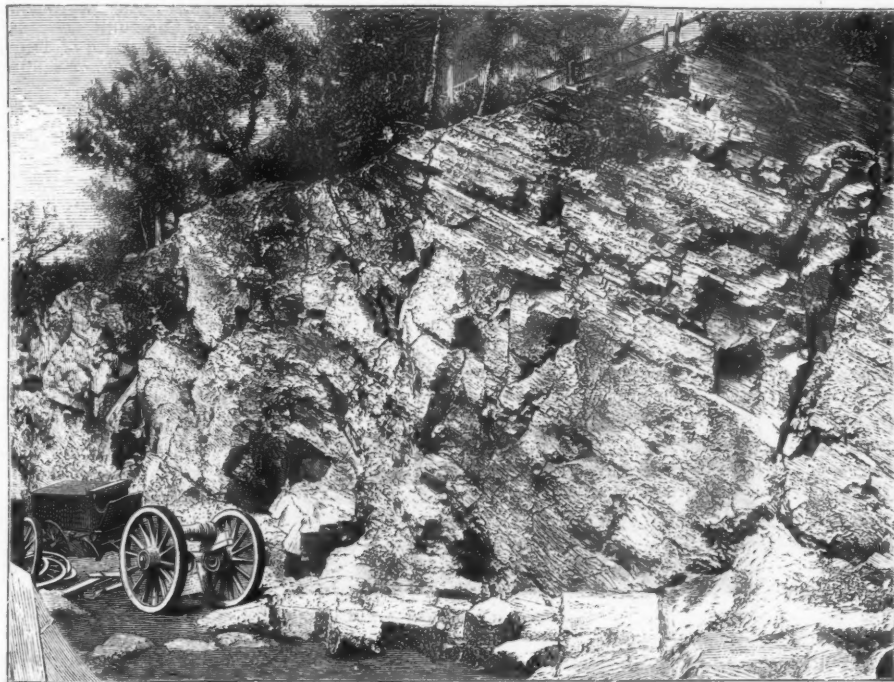


FIG. 8.—Blown-sand Rocks, Bermudas.

peculiarly fine flavour. Sugar-cane, cassava, maize, sweet potatoes, were grown in large quantities. The species of land animals on the island are not numerous, but individuals of several of them are most abundant; two species of lizards are recorded from the islands, one being peculiar to the group.

On the 4th of September the *Challenger* was some 90 miles south of Cape St. Roque, in 2,275 fathoms, with globigerina ooze. On the 8th she was off Parahyba, in 2,050 fathoms, with mud. On the 9th the sounding gave a depth of only 500 fathoms off Cape San Agostinho. The depth increased off Macayo (September 11) to 1,715 fathoms, diminishing off the mouth of the River San Francisco to 1,200 fathoms, and as the coast at this spot was approached to 700 fathoms. On the 14th the *Challenger* was at Bahia, and stopping there a short time she proceeded for a section across the Atlantic from Bahia to the Cape of Good Hope. Owing to unfavourable winds

and other causes, the little Island of Trinidad, an island whose vegetation was then totally unknown, had to be passed by, and the ship's course was directed to the little-known islands of Tristan d'Acunha, and on the 18th of October she was anchored on the north side of the large island which gives its name to the group. This island rises in a range of almost perpendicular cliffs of black volcanic rock, in appearance somewhat similar to that exposed in section on the Grande Curral, in Madeira. At their base are debris slopes, and a narrow strip of low shore-land, on a portion of which lies the settlement. Unfortunately, before much even of these slopes could be explored by the landing party, a sudden squall came on; the recall was hoisted from the ship, and they had to leave after a visit of only six hours. Grasses, sedges, mosses, and ferns were found growing on the cliffs, and hepaticæ so abundant as to cover the earth with quite a green sheet; occasional patches of *Phyllica arborea* were

seen. This tree, belonging to the family Rhamnaceæ, is peculiar to these islands and to Amsterdam Island, in the South Indian Ocean. *Lomaria alpina*, when found in stony places, bore fertile fronds, while those growing in rich vegetable mould were barren. Some of our common weeds were finding themselves at home, such as the sow-thistle. That lovely little cinchonaceous plant, *Nertera depressa*, was very abundant. Growing round the island was a belt of that gigantic sea-weed, *Macrocystis pyrifera*, which abounds in the southern temperate zone. Single plants often grow to a length of 200 feet, and it is said that they sometimes are met with from 700 to 1,000 feet in length, forming cable-like masses nearly as thick as a man's body. There was no time to explore the high plateau; but one interesting observation was made, indicating the presence of snow on the hills, for while the temperature of the fresh-water ponds at the sea-level gave a result of 54° F., that of the streams running down the cliffs was but 50° F.

They had an opportunity of visiting the two other islands of this group, Inaccessible Island, about twenty-three miles W. by S. of Tristan d'Acunha, and Nightingale Island, about twelve miles from Inaccessible Island. On this latter

two Germans were found, who had succeeded in cultivating the ground in the neighbourhood of their dwelling. On both islands *Phylica arborea* was found, and the trees were covered with fully-developed green fruits. A tussock grass, apparently very close to *Dactylis caspitosa*, of the Falklands, grew in immense, almost impenetrable masses on Nightingale Island, amid these countless penguins had established themselves. It was but with the greatest difficulty that a passage could be forced through such a thicket, the grass being too high to allow of the planning of any definite track, and the screaming and biting of the penguins was the reverse of agreeable. This island is never visited except during the sealing season, and is not over one square mile in extent, a veritable speck in the ocean.

The ship's head was now turned for Simon's Bay. Five stations between these points were selected for observation. The depth varied on this line from 2,100 to 2,650 fathoms, the bottom yielding red mud at the greater, and grey mud at the lesser depths. The 28th of October saw the *Challenger* at anchor off Capetown.

Simon's Bay was left about the 14th of December, six weeks having been spent in recruiting and refitting. Even

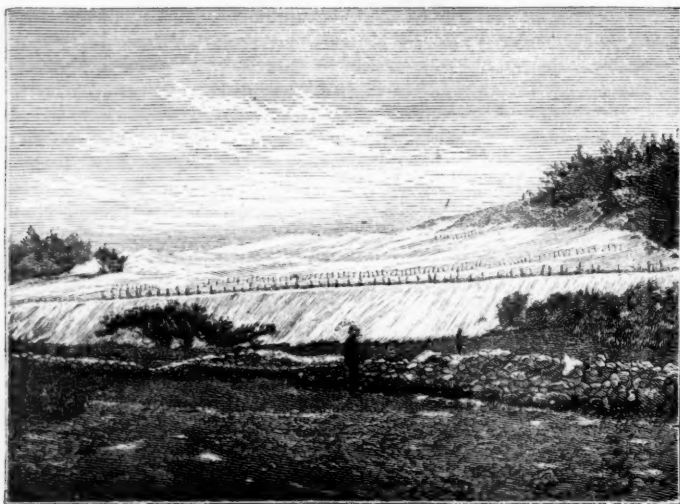


FIG. 9.—Sand-glacier, Bermudas.

in the comparatively well-worked-out district of Capetown new discoveries were made, of which by far the most important was Mr. Moseley's discovery of the tracheal system in *Peripatus capensis*, an account of which has been published in a late volume of the *Philosophical Transactions*. This tracheal system, though conspicuous in the fresh condition, becomes scarcely visible when the animal has been some time in spirit, and the air has been thus removed, hence the failure of Grube, Saenger, and others to see it. The first soundings during the southern course were taken in the region of the Agulhas Current on the 17th and 18th of December. These soundings would have been naturally logged "greenish sand," but on examination were found to consist almost without exception of the casts of foraminifera in one of the complex silicates of alumina, iron and potash, probably some form of glauconite; this kind of bottom had been met with once or twice, but is evidently quite exceptional. Going still south, Marion Island was visited for a few hours and a considerable collection of plants, including nine flowering species, was made. Dredging near the island gave a large number of species, many representing northern types, but with a mixture of southern forms. On the 30th of December, being then between

Prince Edward's Island and the Crozets, the dredge was let down to a depth of 1,600 fathoms, and a vast number of species belonging to the well-known genera *Euplectella*, *Hyalonema*, *Umbellularia*, *Pourtalesia*, as well as two new genera of stalked crinoids, several quite new spatangoids, and several remarkable crustacea were taken.

1874

The new year opened with a storm, and they could not land on Possession Island, on account of the weather; though a dredging in 210 and another in 550 fathoms about eighteen miles to S.W. of the island were made with satisfactory results. On the 7th of January Kerguelen Island was reached, and the *Challenger* remained there till the 1st of February. During that time Dr. v. Willemoes-Suhm was chiefly occupied in working out the land fauna, Mr. Moseley collected the plants, Mr. Buchanan attended to the geological features, while Prof. Wyville Thomson and Mr. Murray dredged in the shallow waters round the islands with the steam-pinnace. Many observations were made, some on the development of the Echinoderms, and great collections were stored away. On one occasion the trawl

net came up nearly filled with some large cup sponges, probably belonging to the same species as was dredged up by Sir James Clarke Ross many years ago near the Ice-barrier. On the 2nd of February they were 140 miles south of Kerguelen, and on the 6th they reached Corinthian Bay in Yong Island, and had made all arrangements for examining it, when a sudden change of weather obliged them to put to sea, though one or two of the party had succeeded in spending an hour or two on shore. The most southerly station made was on the 14th of February in lat. $65^{\circ} 42' S.$, long. $79^{\circ} 49' E.$, when the trawl brought up from a depth of 1,675 fathoms a considerable number of animals. Dredging so near the Antarctic circle was, however, not only a severe but a somewhat critical operation; the temperature of the work-rooms for days averaged seven or eight degrees below freezing point, the ship was surrounded by icebergs, and snow-storms from the south-east were constantly blowing against her.

On the 23rd of February the wind had risen to a whole

gale, the thermometer fell to $21^{\circ} F.$, the snow drove in a dry blinding cloud of exquisite star-like crystals, which burned the skin as if they had been red hot, and none were sorry to turn northwards. This was a period of sore anxiety to all in charge; still observations on temperature were carried on, the specific gravity of the water was taken daily by Mr. Buchanan, and some interesting observations were also made on sea-water ice. The soundings and dredgings, while they were among the ice in 1,675 to 1,975 fathoms, gave evidence of a very distinct deposit of yellowish clay, with pebbles and small stones, and a considerable admixture of Diatoms, Radiolarians, &c., the former doubtless being a deposit from the melting icebergs. Soundings were made on the 26th of February, and 3rd and 7th of March in 1,800 fathoms, when some very remarkable large-sized star-fishes were met with. On the 13th of March, at a depth of 2,600 fathoms, with a bottom temperature of $5^{\circ} 2 C.$ *Holothuræ* were abundant, as well as many other animal forms.

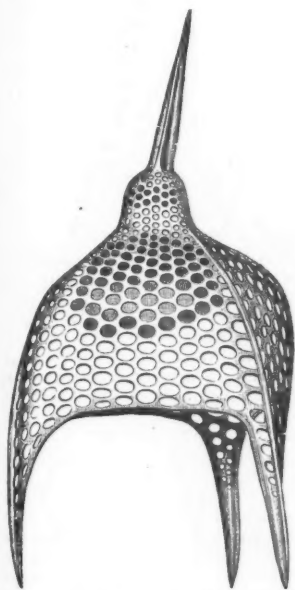


FIG. 10.—Radiolarian.

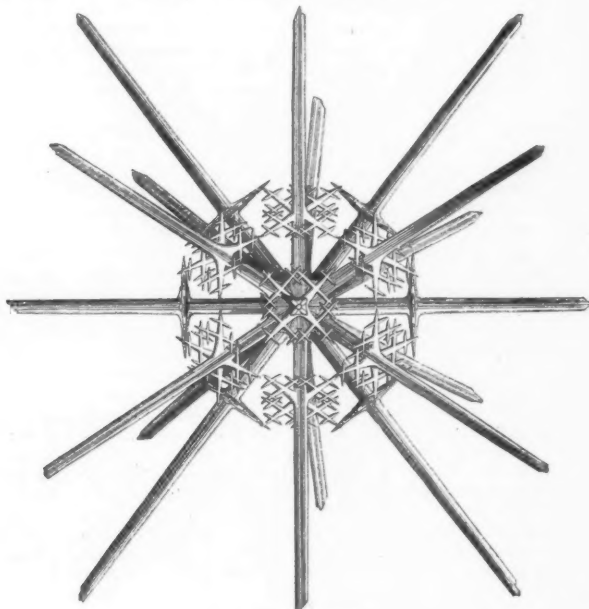


FIG. 11.—Radiolarian.

Melbourne was reached on the 17th of March, and some weeks were pleasantly spent, which were all the more refreshing after the hardships of the tour to the Antarctic circle. Next Sydney was visited, and here everything was done by the inhabitants to welcome the members of the Expedition that could be done, and there is no doubt that the memory of their visits to our Australian Possessions will linger among the pleasant ones that they will indulge in for years. A very careful survey of that portion of the Pacific Ocean that intervenes between the coasts of Australia and New Zealand was required for electric telegraph purposes, and the soundings made by the *Challenger* gave every reason to expect that it would not be long ere New Zealand would be in telegraphic connection with Europe—as indeed it now is. Until the end of June the *Challenger* was engaged on this work, but on the 6th of July, 1874, she set out once more on an ocean cruise.

Leaving Wellington on the 7th she proceeded under sail along the east coast of New Zealand. On the 10th they were about forty miles to the east of East Cape, and continuing their course towards the Kermadec Islands, on the 14th they were off Raoul Island. The

specimens brought up from a depth of 600 fathoms were just such as one would have expected to find in a similar depth off the coast of Portugal. On the evening of the 19th they arrived at Tongatabu, one of the Friendly Islands. Two days were spent in visiting different parts of the island, and a few hauls of the dredge were made in shallow water off the coast. They next made a straight course for Matuku Island, the most southerly of the Fijis, where, on the 24th, a party of surveyors and naturalists landed; some others explored the sea along the coast, trawling in some 1 to 300 fathoms, and procuring, among other fine things, a specimen of the Pearly Nautilus (*Nautilus pompilius*), which was kept alive in a tub of salt water for some time so as to watch its movements. Kandavu was reached on the 25th, Levuka was visited on the 28th, and the ship returned to Kandavu on the 3rd of August, to remain for a week. The natural history of the coral reefs surrounding the Fijis was examined by the civilian staff, who received every assistance possible from Mr. Layard, H.M. Consul. Between New Zealand and the Fiji group only two soundings had been taken to a greater depth than 1,000 fathoms; one off Cape Turnagain, New

Zealand, gave a bottom of grey ooze at 1,100 fathoms, and the other, midway between the Kermadecs and Friendly Islands, gave red clay at a bottom of 2,900 fathoms; the other dredgings and soundings were in depths of from 3 to 600 fathoms, and many of the former yielded an abundance of animal life.

On the 10th of August the *Challenger* left for Api, one of the least known of the New Hebrides, and on the 18th anchored off the island. Capt. Nares had given a passage from Fiji to eleven men of Api, and two or three of the officers, with an armed party of marines, took the returned labourers on shore. The natives appeared somewhat mistrustful, and were armed with clubs, spears, and bows with sheaves of poisoned arrows; so that it was not thought prudent to go into the forest. The natives were almost entirely naked, and were of rather a savage and forbidding aspect. From Api the *Challenger's* course was to the north-westward, towards Raine Island, which is in a breach of the great barrier reef not far from the entrance to Torres Straits. A sounding on the 19th, in lat. $16^{\circ} 47' S.$, long. $165^{\circ} 20' E.$, at a depth of 2,650 fathoms, with a bottom of red clay, gave a bottom temperature of $17^{\circ} 7 C.$ ($35 F.$). A serial temperature sounding was taken to the depth of 1,500 fathoms, and it was found that the minimum temperature ($17^{\circ} 7 C.$) was reached at a depth of 1,300, and that consequently a stratum of water at that uniform temperature extended from that depth to the bottom.

Serial temperatures were taken on the 21st, 24th, 25th, 27th, and 28th of August, in 2,325, 2,450, 2,440, 2,275, and 1,700 fathoms respectively, and in each case the minimum temperature of $17^{\circ} 7 C.$ extended in a uniform layer, averaging 7,000 feet in thickness, from the depth of 1,300 fathoms to the bottom. The area over which this temperature existed has been called the "Melanesian Sea," and it is evident that there is no free communication between it and the outer ocean to a greater depth than 1,300 fathoms, the encircling barrier being complete up to that point. The animals procured in this sea were few in number, but sufficient to show that the existence of a fauna is not impossible in the still bottom-water of such an inclosed area, though, as in the Mediterranean, such conditions do not appear to favour life.

On the 31st Raine's Island was visited, and found to be just as described by Jukes; a collection of the birds breeding there was made, and the next day, the 1st of September, the ship was at Cape York. Proceeding thence across the Arafura Sea to the Aru Islands; Dobbo, a town on the Island of Wamma, was reached on the 16th. After a few days spent in shooting some birds of Paradise and getting an idea of the natural history of the place, they proceeded to Ké Doulan, the principal village in the Ké group, thence to the Island of Banda, where they remained a few days, and thence to Amboina, which was reached on the 4th of October. In some of the dredgings between Ké and Amboina a wonderful assemblage of forms were met with, not only new Pentacrinoid forms, but many new vitreous sponges—Echinoderms, Crustacea, &c. From Amboina they went to Ternate, and thence across the Molucca Passage into the Celebes Sea, by the passage between Bejaren Island and the north-east point of Celebes. Crossing the Celebes Sea, Zamboanga was reached on the 23rd; and the Sulu Sea on the 26th. Capt. Chimmó's observations on this basin-sea were confirmed. Ilo-Ilo was visited on the 28th, and proceeding by the eastern passage round Mindoro, Manila was made on the 4th of November, and after a short stay at the Philippines, Hong-Kong was made headquarters for a time. During the *Challenger's* stay here Capt. Nares received a telegram offering him the command of the Arctic Expedition. This was a great blow to all of the party. Though sorry to part with one who had so far brought the expedition successfully on its way, the importance was fully recognised of having a man of his

character and experience in command of the North Pole Expedition. Capt. Thomson, who was already on the China Station in command of the *Modeste*, took Capt. Nares's place.

1875

Hong-Kong was left on the 6th of January, with the intention of sailing to the region of the Equator, then making a series of stations parallel to it, for a distance of some 2,000 miles, and eventually going north to Japan. Proceeding to the middle of the China Sea, a series of temperature soundings were taken, the temperature at the bottom of 1,200 fathoms being $36^{\circ} F.$ This is accounted for by Chimmó's statement that the China Sea is cut off, by a barrier rising to a height of 800 to 900 fathoms below the surface of the water, from communication with the waters of the Antarctic Ocean. Passing along the west coast of Luzon, the *Challenger* entered the Panay Sea, where further observations were made; visiting Zebu, the first known locality for the "Venus Flower-basket," where some fine specimens of this sponge were obtained in the dredge. Next the ship made for the little island of Camaguin—between Mindanao and Bohol—to inspect the active volcano there on. This volcano was ushered into existence on the 1st of May, 1871, and presented at the time of the *Challenger's* visit the appearance of an irregular cone of 1,950 feet in height; its base was gradually extending, and had covered the town of Catarman. From Camaguin the *Challenger* went along the west coast of Mindanao to Zamboanga, which was (for the second time) reached in the last week of January (29th). A little party of sportsmen were sent off to camp out in the forest within riding distance of the ship; visits were paid to them from time to time, and they thoroughly enjoyed their brief sojourn in the heart of a most exquisite little bit of tropical scenery, and surrounded by multitudes of monkeys, galeopithecids, and many more of the strange denizens of such woods. Thus was a pleasant week spent, and with some regrets Zamboanga was left on the 8th of February. The following day was spent in the strait between Mindanao and Basilan. The view of both islands from the strait was extremely beautiful from the luxuriance of the vegetation which filled up the gullies and mantled over every basalt ridge and peak up to their very summits. On the 9th the party were off Cape Sarangan and in view of Balat, the finest of the Sarangani Islands, with a fine volcanic cone thickly wooded to the top. On the 10th they had a very successful haul of the dredge off the Island of Tulur, in 500 fathoms, getting many specimens of three or four species of *Pentacrinus*, with stems two or three feet high. About this time the wind felt very light and uncertain, and a strong current was setting them down towards the coast of New Guinea. The coal supply was running short, and was required for dredging and sounding up to Japan, the nearest place for a fresh supply; so Capt. Thomson determined to make for Humboldt Bay. On the 21st of February, still drifting southwards, they were opposite the delta of the great river Ambernoh, which rises in the Charles-Louis Mountains, a splendid range in the interior of New Guinea, upwards of 16,000 feet high, and falls into the sea at Cape D'Urville, to the east of the entrance of Geelvink Bay. Night was falling on the 23rd as the *Challenger* cast anchor just within the headlands of Point Caillé and Point Bonpland. Next morning, shortly after daybreak, the ship was surrounded by about eighty canoes, each from 15 feet to 20 feet long, and with crews of from four to six men each. There were no women or children among them. The men were unusually good-looking for Melanesians, and wonderfully picturesque; they seemed on an average about 5 ft. 4 in. in height, features tolerably good, nose rather thick and flat, eyes dark and good, expression agreeable, mouth large, and lips rather full; betel and chinam-chewing had destroyed their teeth and dyed their gums crimson, and their ear-lobes were greatly lengthened by earrings. Their

hair is frizzled, not woolly, very thick, and worn in the shape of a huge round mop; it was partly bleached by lime, or coloured red by lime and ochre; black and white feathers and coronals of scarlet Hibiscus flowers were worn on their heads; the face was smeared with black or red pigment; with the exception of a few ornaments the body was entirely naked; the skin dark-brown in the shade, warmed to a rich red-brown in the sunlight. A band of tappa, variously ornamented, encircled the middle of the upper arm on both sides, and into this they stick, towards the outside of the arm, large bunches of the fresh green and white leaves of a beautiful narrow-leaved Croton. The natives were well armed with strong bows and arrows, the latter five to six feet long, with heads bristling with barbs. In almost every canoe there were stone hatchets mounted on hard-wood handles, closely resembling those found in Denmark; they were made of a hard, close-grained green stone, taking a jade-like polish. The canoes had generally a grotesquely-carved prow, the paddles being of hard wood, leaf-shaped, and often prettily carved.

In the course of the afternoon Capt. Thomson and Prof. Wyville Thomson went in the galley to an island where there was a village, to ascertain the temper of the natives, and see if it were safe to go about freely. They were rowed to a sandy beach, and made signs that they wished to land, but the whole population, consisting chiefly of women and boys, all armed with bows, turned out with the most determined demonstrations of hostility. The women were not prepossessing, the young girls were perfectly naked, and wore no ornaments; the matrons wore a fringe of rough bark-cloth round their loins. The village consisted of some twenty to thirty huts, some on land under the trees, but most of them built on a platform raised a few feet above the surface of the sea on piles, and communicated with the shore by planks removed at pleasure. Another boat sent off to get sights had been caught hold of by the natives and plundered, but no attempt at retaliation had been made by the crews. Had things gone on well, the *Challenger* would have remained at Humboldt Bay for five days, but Capt. Thomson made up his mind not to submit to the pilfering that was going on, nor to risk the chance of a rupture, and after careful consideration and consultation, went on towards Admiralty Island the same evening. During the afternoon the Captain, Prof. Wyville Thomson, and Mr. Murray, managed to land on the shore of the bay by going in a canoe with some natives, and during an hour's ramble on shore, Mr. Murray had the good luck to see three of the wonderful crested ground pigeons of the genus *Goura*, which are nearly as large as turkeys.

During the next week the ship gradually made her way, with light winds and heavy rains, and close depressing, equatorial weather, past the Schouten Islands and Hermit Island towards Admiralty Island, where it arrived on the 3rd of March, and anchored in a lovely bay in eighteen fathoms; this they called Nares Bay, in compliment to the head of the Arctic Expedition, their former captain. The natives are Papuan Melanesians, but partake more of the characters of the Papuans of New Ireland and New Britain than of those of New Guinea. Here bows were unknown and the natives used spears, with heavy heads of obsidian and light shafts 6 to 7 feet long; they also use long sharp knives or daggers of obsidian, and almost every man had over his shoulder a neatly mounted little adze made of a small piece of hoop iron; a few carried implements of the same form, but the cutting part made of a piece of a thick shell ground down. Here the natives made no great opposition to the party landing, only hurrying them past or away from their villages and warning their women to keep out of sight. Sometimes the curiosity of the women would overcome their discretion, and little groups would come out to see the strangers. These were anything but pleasing-looking;

they wore no clothing except two fringes of grass or palm-leaves. In the course of a few days all the party were quite at home with the natives, and went and came as they pleased. The natives were found to be totally ignorant of the use of tobacco and spirits; but though they showed many good points, yet there are the gravest suspicions that they dispose of their dead in a very economical though hideously repulsive way. Some of the small islands literally swarmed with the beautiful large nutmeg-pigeons.

On the 10th of March, the *Challenger* steamed out of Nares Harbour, intending to call at one of the more western of the Caroline Islands, and perhaps at some of the Ladrone group, but the explorers were so very unfortunate in the winds that they were driven to the west of both groups, and never again saw land until they sighted the Japanese coast on the 11th of April. This cruise was by far the most trying one during the commission. The weather for the greater part of the time had been excessively sultry and depressing, and before entering on it

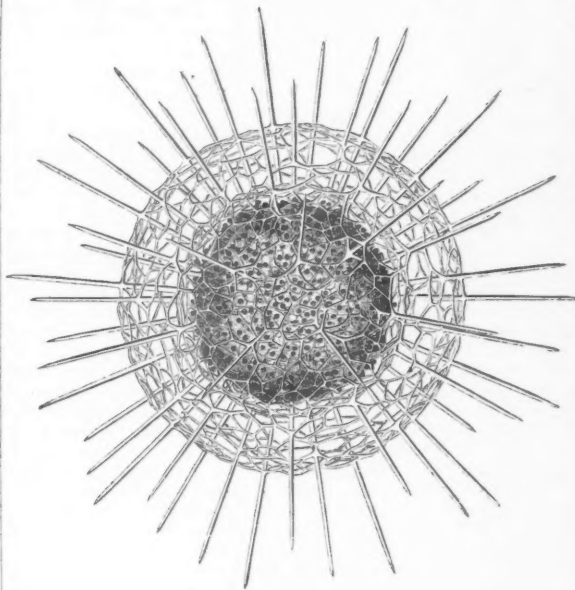


FIG. 12.—Radiolarian.

they had been nearly a year in the Tropics. The section from the Admiralty Islands to Japan, 2,250 miles long, was practically meridional; the observing stations were twelve in number and pretty regularly distributed. The greatest depth was found on the 23rd of March, in 4,575 fathoms. With the exception of two soundings taken by the *Tuscarora* off the east coast of Japan, in 4,643 and 4,655 fathoms respectively, this is the deepest trustworthy sounding on record. A second sounding to check the first gave 4,475 fathoms, and in this the tube of the sounding-machine contained an excellent sample of the bottom, which was of a very peculiar character, consisting almost entirely of the siliceous shells of Radiolaria. In these the body may have a more or less fully developed external siliceous skeleton minutely fenestrated, and often presenting very remarkable and beautiful forms (Fig. 10), or the skeleton may be essentially internal and be formed of a number of siliceous spicules radiating from a centre round which the sarcodis is accumulated as in *Xiphacantha* (Fig. 11). Or again they may give off a set of finely anastomosing branches which form one or several concentric lacey shells, which invest the sarcodis nucleus as in *Haliomma*

(Fig. 12). These lovely forms occurred in such numbers in this sounding as almost entirely to mask the "red clay."

The most marked temperature phenomenon observed in this part of the cruise was the presence of a surface layer of water at a depth of 80 fathoms and a temperature above 77° F., extending northwards from the coast of New Guinea, about 20°, and westward as far as the meridian of the Pelew Islands. The greater part of this vast mass of hot water is moving with more or less of rapidity to the westward.

The travellers, weary and worn out by their assiduous labours in the Tropics, had a welcome and a well-deserved rest at Japan. The wonders of Yeddo and the freshness of the climate soon restored them to vigour. Short excursions were made and various towns and villages were visited. A cruise was made after a time to Kobe and along the south-west coast of Nipon, and on the 16th of June the *Challenger* left Yokohama, and ran an easterly course between the parallels of 35° and 40° north latitude, as far as the meridian of 155° east. She then went nearly directly southwards and reached Honolulu, one of the Sandwich Islands, on the 27th of July.

Between Japan and these latter islands twenty-four observing stations were satisfactorily established. At the first station, just forty miles to the south-east of No-Sima Lighthouse, they had a successful trawl, and among a mass of starfish and other Echinoderms there was found a giant hydroid polyp, apparently referable to the genus *Monocaulus*. The hydranth was 9 inches across from tip to tip of the expanded (non-retractile) tentacles, and the hydrocaulus or stem was 7 feet 4 inches high, with a diameter of half an inch. This wonderful form was found once again nearer to Honolulu. The deepest sounding got off Japan was 3,950 fathoms, with a red clay bottom. The temperature observations gave a singular result; the surface temperature had fallen to 65° F., and the belt of water above 50° F. was reduced in depth to considerably less than 100 fathoms, while all the isotherms, at all events to a depth of 400 fathoms, rose in proportion. There seems to be little doubt, from a comparison of the American temperature results with those of the *Challenger*, that this sudden diminution of temperature is due to a cold-surface flow from the sea of Okhotsk, and possibly attaining its maximum at the season of the melting of the snow over the vast region drained by the Amoor and Siberian Rivers with a southern overflow.

The soundings from Yokohama to Honolulu were very uniform as to depth. The average of twenty-two being 2,858 fathoms, and the bottom was pretty generally red clay. In some cases the trawl came up half filled with large lumps of pumice, which seemed to have drifted about till they became water-logged. The red clay was also found full of concretions, mainly consisting of peroxide of manganese, round, oval, or mammillated, and very irregular, varying in size from a grain of mustard seed to a large potato. On breaking these they are found to consist of concentric layers, having a radiating fibrous arrangement, and usually starting from a nucleus consisting of some foreign body, such as a piece of pumice, a shark's tooth, or such like.

A delightful fortnight was spent on the Sandwich Islands; numerous excursions were undertaken. In the Government Library at Honolulu there was a splendid collection of scientific books, which enabled many points in the natural history of some of the species found to be verified. On the 11th of August Hawaii was visited, and the crater of Kilauea was explored. On the 19th Hawaii was left, and the course of the *Challenger* was due south to Tahiti. Many soundings and dredgings were made on the way, the average depth being 2,800 fathoms, with a bottom of red clay, and many things of great interest to the biologist were discovered. Tahiti was reached early in September, and amid the charms of this island, by

some better known as Otaheite, the time sped quickly until October; every opportunity was made use of to get acquainted with the productions, climate, geological structure, and inhabitants of the island. Leaving it on the 2nd a section was made across to the island of Juan Fernandez, a distance of about 4,000 miles, with an average depth of 2,160 fathoms. Juan Fernandez was reached on the 13th of November, and two days were spent exploring every corner of it, and large collections were made. The ship anchored in the harbour of Valparaiso on the 19th. Three weeks were here spent to recruit, and then the *Challenger*, leaving on the 10th of December, started on a cruise round Cape Horn to the Falklands.

1876

The Falkland Islands were reached about the 10th of January, and some three weeks being spent in explorations among the islands on the South American Coast, Monte Video was visited on the 15th of February, when, after a week's sojourn, homewards was the cry, and on the 23rd the *Challenger* left for her last section across the Atlantic in the direction of Ascension Island and St. Vincent. At the Cape de Verd Islands she once more was in familiar waters and had encircled the world. The former was reached on the 27th of March, and a week was spent at George Town, when stores were completed and a few supernumeraries taken on board. On the 18th of April St. Vincent was reached, and the final start for home made on the 26th; her arrival at Spithead on the 24th of May is now matter of history. We are glad to be able to report that all of both staffs are in the enjoyment of perfect health.

This sketch of the *Challenger's* cruise has, from the very necessity of the case, been an imperfect one; time and space both failed, or we would have gladly told of visits to Heard Island, the strange breeding-place of the giant albatross, of fights with sea-elephants, and of many of the new and rare animals found in the depths of the three oceans. We would here also like to have subjoined a sketch of the chief scientific results of the voyage; but perhaps it were better left undone, for we know that a "Narrative of the Cruise of the *Challenger*," from the able pen of the head of her civilian staff, is already in an advanced stage of preparation. From the glimpses we have got of it, from the beauty of the illustrations (some of which adorn this sketch) that will appear in it, we feel sure that it will be one of the most deeply interesting as well as fascinating books published. It will be not a mere narration of events, but contain, as well, descriptions and figures of all the new forms, forming a most worthy contribution to Physical Geography, to Ethnology, and to Zoology and Botany.

In conclusion we append a tabular abstract of the voyage of the *Challenger*:-

From	To	Date		Distance made good
		Sailing	Arrival	
Sheerness ...	Portsmouth ...	Sat. Dec. 7, '72	Wed. Dec. 11, '72	200
Portsmouth ...	Lisbon ...	Sat. Dec. 21, '72	Fri. Jan. 3, '73	1091
Lisbon ...	Gibraltar ...	Sun. Jan. 12, '73	Sat. Jan. 18, '73	340
Gibraltar ...	Madeira ...	Sun. Jan. 26, '73	Mon. Feb. 3, '73	615
Madeira ...	Teneriffe ...	Wed. Feb. 5, '73	Fri. Feb. 7, '73	235
Cruising off Teneriffe ...	...	...	...	230
Teneriffe ...	St. Thomas ...	Fri. Feb. 14, '73	Sun. Mar. 16, '73	2879
St. Thomas ...	Bermuda ...	Mon. Mar. 24, '73	Fri. April 4, '73	870
Bermuda ...	Halifax N.Y. ...	Mon. April 21, '73	Fri. May 9, '73	1201
Halifax ...	Bermuda ...	Mon. May 19, '73	Sat. May 31, '73	796
Bermuda ...	St. Michaels Azor ...	Friday, June 13, '73	Fri. July 4, '73	2031
St. Michaels ...	Madeira ...	Wed. July 9, '73	Wed. July 16, '73	548
Madeira ...	St. Vincent ...	Thur. July 17, '73	Sun. July 27, '73	1066
St. Vincent ...	Porto Praya ...	Tues. Aug. 5, '73	Thur. Aug. 7, '73	170
Porto Praya ...	St. Paul's Rock ...	Sat. Aug. 9, '73	Wed. Aug. 27, '73	1953
St. Paul's Rock ...	Fernando Noronha ...	Fri. Aug. 29, '73	Mon. Sept. 1, '73	344
Fernando, N. ...	Bahia ...	Wed. Sept. 3, '73	Sun. Sept. 14, '73	815
Bahia ...	C. of Good Hope ...	Thur. Sept. 25, '73	Tues. Sept. 28, '73	2089
Total of First Section of Voyage ...				19397

From	To	Date		Distance made good
		Sailing	Arrival	
C of Good Hope	Melbourne	Wed. Dec. 17, '73	Tues. Mar. 17, '74	7637
Melbourne	Sydney	Wed. April 1, '74	Mon. April 6	550
Sydney	Wellington	Mon. June 8...	Sun. June 28	1432
Wellington	Tongatabu	Tues. July 7...	Sun. July 19	1547
Tongatabu	Ngaloa Bay	Wed. July 22...	Sat. July 25...	490
Ngaloa Bay	Levuka	Mon. July 27	Tues. July 28	120
Levuka	Ngaloa Bay	Sat. Aug. 1	Mon. Aug. 3	120
Ngaloa Bay	Port Albany	Mon. Aug. 10	Tues. Sep. 1	2250
Port Albany	Dobbo	Tues. Sep. 8...	Wed. Sep. 16	656
Dobbo	Kei Doulan	Wed. Sep. 23	Thurs. Sep. 24	100
Kei Doulan	Handa	Sat. Sep. 26...	Tues. Sep. 29	200
Handa	Amboina	Fri. Oct. 2	Sun. Oct. 4	115
Amboina	Ternati	Sat. Oct. 10...	Wed. Oct. 14	370
Ternati	Samboangan	Sat. Oct. 17...	Fri. Oct. 23	511
Samboangan	Ilo Ilo	Mon. Oct. 26	'ed. Oct. 28	220
Ilo Ilo	Manila	Sat. Oct. 31...	Wed. Nov. 4	350
Manila	Hong Kong	Wed. Nov. 11	Mon. Nov. 16	650

Total of Second Section of Voyage ... 17158

Hong-Kong	Manila	Wed. Jan. 6, '75	Mon. Jan. 11, '75	650
Manila	Zebu	Thur. Jan. 14	Mon. Jan. 18	380
Zebu	Camaguin Ids.	Sun. Jan. 24...	Tues. Jan. 26	110
Camaguin Ids.	Samboangan	Tues. Jan. 26	Fri. Jan. 29...	250
Samboangan	Humboldt Bay	Fri. Feb. 5	Tues. Feb. 23	1333
Humboldt Bay	Admiralty Island	Wed. Feb. 24	W. d. Mar. 3...	493
Admiralty Island	Yokohama	Wed. Mar. 10	Sun. April 11	233
Yokohama	Kolu	Tues. May 11	Sat. May 15...	350
Kolu	Miwarra	Tues. May 25	Wed. May 26	120
Miwarra	Kolu	Fri. May 28...	Sat. May 29...	120
Kolu	Yokohama	Wed. June 2	Sat. June 5	400
Yokohama	Honolulu	Wed. June 16	Tues. July 27	4302
Honolulu	Hilo	Wed. Aug. 11	Sat. Aug. 14...	370
Hilo	Tahiti	Thur. Aug. 19	Sat. Sept. 18...	2630
Tahiti	Juan Fernandez	Sun. Oct. 3	Sat. Nov. 13...	4643
Juan Fernandez	Valparaiso	Mon. Nov. 15	Fri. Nov. 19...	400

Total of Third Section of Voyage ... 18824

Valparaiso	Messier Channel	Sat. Dec. 11, '75	Sat. Jan. 1, '76	2033
Messier Channel	In Magellan Straits	Sun. Jan. 2, '76	Wed. Jan. 19	710
In Magellan Straits	Magellan Straits	Thurs. Jan. 20	Sun. Jan. 23	400
Magellan Straits	Falkland Ids.	Sun. Feb. 6	Tues. Feb. 15	1172
Falkland Ids.	Monte Video	Fri. Feb. 25	Mon. Mar. 27	3720
Monte Video	Ascension	Mon. April 3...	Tues. April 18	1800
Ascension	St. Vincent	Wed. April 26	Sat. May 20	2846
St. Vincent	Vigo	Sun. May 21...	Wed. May 24	700
Vigo	Portsmouth	Fri. May 26...	Sat. May 27	200

Total of Fourth Section of Voyage ... 13581

Grand Total ... 68930

NATURAL HISTORY AT THE ROYAL ACADEMY

WE will leave to other journals the task of criticising the present Exhibition of works of Art at the Royal Academy, and without entering deeply into the question of grouping composition, solidity of painting, *chiaroscuro*, perspective, *morbidezza* of flesh treatment, or aerial effect, we will confine ourselves to a few remarks in a less ambitious key, on those pictures which portray animal life. Of this class there are several important examples devoted entirely to the representation of wild or domesticated animals, with others in which the lower forms of creation play but a slightly inferior part; and in these days when the public taste claims a far more conscientious treatment of the subject than in former times, we may be allowed, without being taxed with unfair criticism, to examine how far the respective artists have succeeded in fidelity of execution.

In the first gallery the eye is at once attracted to a large work by Mr. F. Goodall, R.A., "An Intruder on the Bedouin's Pasture" (14), representing a Nubian riding on a dromedary accosting some nomads. The drawing of the centre camel is excellent, although the animal is perhaps a trifle too clean and shiny; the other camels are somewhat unequal in point of execution. In the foreground are some capitolly painted goats, and a scarabeus is crawling along the sandy bank, whilst on the left by a small pool of water, two wagtails are strutting, one of which was evidently drawn from a badly stuffed specimen. The distance and atmosphere are admirably

rendered, far better than in another picture where camels are also the prominent objects, that of Mr. R. Beavis, (85), "Bedaween Caravan on the Road to Mount Sinai," in which the atmosphere is somewhat cold and grey. On the other hand, the action of Mr. Beavis's two advancing camels is perfect, whilst the position selected is one of extreme difficulty; there is a roughness and vigour in these animals that make Mr. Goodall's dromedaries look by comparison like mere stuffed models. In his other contribution, "Ploughing in Lower Egypt" (484), representing a buffalo and a camel yoked together, Mr. Beavis has been less happy; partly, perhaps, because the union of such an incongruous pair cannot look otherwise than ungainly. To the right, some way off, are several birds feeding by the side of the water, and we can just see that they are cranes of some species, which at that distance is all that could be required; but unfortunately there is another bird with these which is only too plainly recognisable, and that is the sacred ibis, which we cannot believe that Mr. Beavis or anyone else has seen in Lower Egypt in the present century, although it was apparently more widely distributed in ancient times. It is indeed doubtful if it still exists in any part of Egypt proper, and the bird usually pointed out to travellers as such by the Nile dragoon, is the buff-backed heron. Mr. J. W. Oakes, A., in his "Sheltered" (36), gives some young gulls in the foreground which have at least the merit of being recognisable as young *Larus ridibundus*, but the drawing of the flying bird's wings and tail is sadly wrong. Mr. S. Carter's "Morning with the Wild Red Deer" (47), depicts a noble stag of twelve points lying down with a hind and fawn; the rough hair is capitolly rendered, but we are a little doubtful as to the accuracy of representing paterfamilias in such company. Of the same artist's "A Noble Victim" (74), a stag fallen dead by the side of a pool with a colly-dog showing his teeth at a young eagle perched on a neighbouring rock, we cannot speak so highly, for the work seems somewhat thin and scamped. His No. 1257, "A Little Freehold," is a family party of squirrels, the young one issuing from a nest like that of a dipper, placed in the large fork of a tree—utterly unlike any squirrel's drail we ever saw.

The first of the works of Mr. J. E. Hodgson, A., "The Temple of Diana at Zaghouan" (84), hardly comes within our scope, but it is a charming composition, showing a sportsman, presumably the artist himself, intruding like a modern Actæon upon a pool in which several Moorish maidens are washing; the savage glances of the black attendants and the curiosity of the girls are humorously given. The spaniel in the foreground must be our excuse for noticing this picture at all, and we are sorry to say that the dog is the worst figure there; but 301, "Following the Plough," comes within our lawful bounds, depicting as it does, a Moor ploughing, followed by several storks which are gathering worms and grubs from the newly turned turrows, whilst on the bushes to the right are perched a hoopoe and a goldfinch. None of these birds are really faultless, but a very conscientious effort has evidently been made to reproduce on canvas the grotesque actions of the storks, and we have no doubt that the artist could easily improve upon this first essay in bird-life.

Of Mr. Millais' grand work, "Over the Hills and Far Away," (106), we need only remark the fidelity of the representation of the hovering kestrel to the left, and the distant pack of red grouse in the distance on the right. The old cock grouse stands crowing on the top of a rock. It has been stated that these birds are meant for black-game, but those who say so had better look again, and they will recognise the touch by which the master-hand has indicated the species. Mr. Hook's first work in the catalogue is No. 44, "Sea-side Ducks," in which the ducks are by no means equal to the fish, cod, skate, whiting, pont,

and gurnard, which lie in well-arranged confusion at a little distance, whilst in No. 186, a carefully-painted dog-fish and skate are seen lying on some crab-pots. In No. 234, "Crabbers," there is abundance of motion in the boat which is just taking in a wave over the bows as one of the fishermen hauls in the crab-pot, but what shall we say of the fine male crab which he is extracting? The face of the crustacean is towards the spectator, but will it be believed that an artist of Mr. Hook's experience has actually placed the huge claws *behind* the legs, instead of in the *front*? Think of the outcry there would have been, if in that over-discussed horse in the "Roll-call," about whose action nobody could agree, the artist had chosen to put the fore-legs where the hind-limbs should have been: it would have been treated as an insult to common sense, for every one knows, or thinks he knows, the points of a horse. But a mere crab, poor *cancer pagurus*, what does it matter where his nippers are placed? We sincerely hope that when Mr. Hook has occasion to paint a live lobster he will not paint it red, although this would be by far the more trivial error of the two.

It is needless to say anything of Mr. T. S. Cooper's cattle pictures, for we have seen the same kind of thing as long as we can remember. In 243, "An Inquisitive Magpie," Mr. Jones has some brown sheep in a brown atmosphere, contemplating a stuffed magpie on a hurdle; the picture is hopelessly "skied," but it may be satisfactory to the artist and to Mr. P. V. Duffy, whose excellent "Flood in the Dargle" hangs next at a similar elevation, to know that their works help materially to tone down the too advancing brown of the tree trunks in Mr. Leighton's "Daphnephoria," hung immediately below.

"Early Summer" (168), by Mr. H. W. B. Davis, A., is a clever landscape with Devon cattle; but by far the grandest work which has ever proceeded from his brush is "Mares and Foals, Picardy" (557), a picture which may challenge comparison with any similar subject by Landseer. In the foreground a foal, bitten by a fly plainly visible on its neck, is plunging wildly over another foal which is lying down; the centre figure is a large white mare, whinnying and showing her teeth at another member of a group which seems generally out of temper, whilst the mare and foal to the left, in repose, are simply perfection. The great mass of white in the centre is most difficult to manage, and in certain lights there is something not altogether satisfactory about the shoulder on the off-side, but when the direct glare of the sun does not fall on the picture, this apparent defect disappears.

Mr. B. Riviere has not been fortunate with his Ducks in a "Stern Chase" (313), and the art critics do not seem favourably disposed to his (496), "Pallas Athene and the Herdsman's Dogs;" but putting the figure of the goddess out of the question, the dogs, which are uncommonly like wolves, are really well drawn, and the attitude of the one rolling on its back is excellently given. There is much humour in the expression of the big mastiff looking down on the skye terrier in Mr. O. Weber's "How do you do" (416), and as they are stated to be portraits, we cannot quarrel with the head of the former, but his chance of a prize at a dog show would be small. In "Home Ties" (435), Mr. E. Douglas gives us a foxhound and litter in kennel, and in 556, "A Bagged Fox," a capital fox-terrier, standing on and watching intently the movements in a sack, from which the bagged fox is just gnawing his way out; in the foreground are two red herrings tied to a cord, indicating that the hounds are generally hunted on the drag, and that a fox is an unwonted luxury—probably he has been purchased to give a brilliant wind up to the season. Two other sporting pictures 231, by W. H. Hopkins, and 357 by S. Pearce, are commendable.

Mr. Ansdell has abandoned Spain this year, and all his pictures but one represent Scotch scenes. In 214 we have the well-known black and white ponies, whilst 619

represents some half-drowned sheep recovered by the shepherds; the fore-legs of the sheep standing upright are absurdly small and out of all proportion. The colly-dog which has just killed a hill-fox caught in the act of devouring a lamb (874), is painted in that artist's usual style, for in dogs he has now no rival, but we miss the life and expression which Landseer used to give to his canine friends. Mr. P. Graham's "Moorland Rovers" (385), a couple of shaggy Scotch cattle, would look better if they were painted on a smaller scale, and the green of the reeds in the foreground strikes us as somewhat vivid in colour.

Mr. Heywood Hardy's 899 is a somewhat ambitious attempt to represent an extremely difficult subject—the animals coming to Noah's ark. It would appear that the artist started with the intention of confining his choice to members of the African or Ethiopian fauna; there are ostriches, giraffes, African elephants and buffaloes, sable antelopes, Dorcas gazelles, and other species, whilst the most obtrusive figures are those of two hippopotami, one of which is opening its enormous jaws to their fullest extent. The deep red of the interior of the beast's mouth has unfortunately necessitated a very serious departure from the original plan, and led to the introduction on the right of the picture of two scarlet *American* ibises, whose office is clearly to tone down the red of behemoth's mouth. We are not altogether satisfied with the presence of the Syrian bear, the horse, and the wild ass, in such company. The foreshortening of the pelican's wing on the left is also incorrect, and, indeed, the birds in general are not satisfactory; but we have to thank Mr. Hardy for clearing up a point which has hitherto been unexplained. We never could understand why the raven never returned to the ark; but after viewing the bird which is looking up wistfully at Noah's feet, and evidently wondering how he is to get up there without anything to walk upon, we see the reason only too plainly. From the moment, that Noah inhumanly "sent him forth," his minutes were numbered; a couple of despairing flops of his incapable wings, and unless Noah promptly lowered a boat, the corpse of the corpse-devourer must speedily have become the sport of the waves which then united the Black and Caspian Seas. But with all its defects, Mr. Hardy's picture is a most meritorious attempt at portraying animals as they really are; nearly every species has evidently been drawn from the live specimens in the Zoological Gardens, and we sincerely trust that the artist will persevere in the line which he has selected.

Miss A. Havers has been very fortunate in her delineation of geese in "Goosey, Goosey-gander" (1266): a girl sitting on a foot-bridge at evening, watching a flock of geese wading in the burn; one of the flock is leaving the rest, and waddling off to the wrong side of the water. It is not everyone who can paint a goose, and it would be difficult to imagine a more accurate representation of the ungainly motions of that despised bird. Equally good in its way is the rendering of the action of a mule just at starting, in Mr. W. J. Hennessy's "En fête, Normandy" (523), which is moreover a charming composition.

It is sad to have to notice such painful failures in animal painting as those of Mr. C. Landseer, R.A., "A Watch Dog" (420), and Sir F. Grant's "The Muckle Hart" (1341); in the latter the recumbent stag has hardly one of his tynes correctly drawn, and the hind in the distance is a fearful and wonderful beast.

With regard to the Statuary, it is difficult to find a place in the lecture-room, whence a good view can be obtained of J. E. Boehm's enormous equestrian group of St. George and the Dragon; but the dragon deserves notice as being a compound of several existing reptilian forms; thus approaching reality as far as is possible with a semi-mythical monster. The body of the dragon is that of a crocodile, the neck and head are those of the *Cerastes* or horned viper, whilst the wings are modelled after those

of the small flying lizard. Mr. G. A. Carter's "Group of Red-deer" (1405) is not a great success, but it will probably look better when executed in silver. There is much merit in Mr. W. Prehn's "Polar Bears" (1455), in which the artist has coloured the snouts and slightly washed the limbs of the animals with yellow to relieve the deadness of such a mass of white; an excusable innovation in the present instance. And last in order we come to two admirable models of "A Wild Boar" (1501), and "A Bear" (1507), by Mr. Joseph Wolf, whose reputation as a delineator of animal life with the brush is unrivalled, but who has never till now turned his attention to modelling. The attitude of the boar is excellent; his face is devoid of any expression, although he has evidently partaken of some vegetables whose remains lie at his feet, but withal there is no sign of enjoyment or satisfaction. It is otherwise with the bear, who has been devouring honey-comb, and who is now licking his chops with an expression worthy of a gourmand, showing that the good things of this life are by no means wasted upon a gentleman of his appreciation. And with this we close our notice of animal life at the Academy, congratulating artists in general upon the increasing tendency to paint their subjects from nature instead of evolving them out of their own inner consciousness. TWO NATURALISTS

THE ETHNOLOGY OF THE PAPUANS OF MACLAY COAST, NEW GUINEA

IN December 1873, when at Batavia, I received from the Russian traveller, Von Miklucho-Maclay, reprints of two articles upon the East Coast of New Guinea and its inhabitants, of which I made a short abstract for NATURE (Feb. 26, 1874), during my voyage from Java to Atchin. The following is the substance of one of two supplementary papers on the same subject,¹ which have been lately sent to me, by Dr. Maclay, from Johore, on the Malay peninsula; which, it would be imagined, should be all the more interesting, as much which is, to say the least, doubtful, has lately been published about New Guinea and its natural productions.

The former papers dealt with the individual characters of the Papuans, while in the present article the food, weapons, dress, dwellings, and daily life of this people will be treated of.

The Food of the Papuan.—That of the inhabitants of MacLAY Coast is principally of a non-animal nature, consisting of fruits and vegetables, of which a list is subjoined in the order of their domestic importance.

The Cocoa-nut (*munki*). This plays a most important part in the economy, as it is obtainable all the year round. The trees are seldom to be met with in the mountain villages, but are numerous on the shores of the neighbouring islands, though here they are confined to plantations around the houses. A favourite dish which never fails at feasts is *munki-la*, a kind of porridge made of the grated kernel of the nut steeped in the so-called "milk." Curiously enough, the preparation of cocoa-nut oil is unknown.

The Dioscorea (*ajan*) is much cultivated in the plantations, and is in condition for food from August till January. It is boiled in water, or when this is difficult of carriage, roasted in ashes. It forms the principal article of diet during the above-named months.

The Collocas (*bau*) is the main article of food from March to August. Like the *ajan*, it is either boiled or baked. Pounded up with grated roasted cocoa-nut, it is made into a kind of cake, which is in great request at feasts. The leaves of the plant are also eaten.

The fruit of the Convolvulus (*degargol*), of which there are two varieties, one red, the other white, is principally

in season in September and October, and is either stewed or baked.

Although no less than eight or nine varieties of Banana (*moga*) were met with by Miklucho-Maclay, owing to its limited cultivation, the fruit is a comparative rarity. The lower part of the stem and the roots of the young plants are also eaten.

On account of the rare occurrence of the Palm affording it, sago (*buam*) is rather a dainty, seen only at feasts, than an article of daily diet.

The Sugar-cane (*den*), which attains a magnificent growth in New Guinea—the edible portion being not infrequently fourteen feet high—is chewed with the greatest zest by men, women, and children, from October to February.

The Bread-fruit (*boli*), though not particularly sought after, is collected and eaten stewed or roasted.

The *Orlan* is the fruit of a tree which Dr. Maclay had no opportunity of seeing. This fruit is hung in great baskets upon the trees in the forests. From the pulp and the kernel of the crushed seed there is derived by fermentation an acid unpleasantly smelling sauce, which is considered a great delicacy.

The Canarium commune (*kengar*) is collected in May, June, and July, dried, and its seed stored.

The fruit of the *Pandanus* (Screw Pine) and *Mangifera* (mango) also occurs, but very sparingly, on MacLAY Coast.

Animal food is of but rare occurrence. The following animals are, however, the most usual sources of food:—

The Pig.—This, a descendant from the wild New Guinea species, is bred in the villages. When young it is striped, but with age it becomes black. The ears are erect, the snout sharp, and the legs long. Pigs are only killed on festal occasions, and then one suffices for two or three villages.

Dogs are kept by the Papuans principally for the sake of their flesh, which, though of fairly good flavour, is, nevertheless, somewhat dry.

The flesh of the Cuscus² (*mañ*) is considered a great dainty, although it has a strong smell.

Fowls, although they occur in the villages, are but seldom eaten; and, as they exist in a semi-wild state, their eggs are not often to be obtained. During a stay of fifteen months Dr. Maclay only saw two eggs in the various villages which he visited.

From the large lizards (Monitors) a white and tender meat is obtainable.

All insects without exception, especially large beetles, are eaten, either raw or cooked, by the Papuans.

As regards fishes, the larger are caught in nets, while the smaller are killed by harpoon at night-time.

Various molluscs and other shell fish are collected on the coral reefs at low water by the women and children of the villages.

As the existence of salt is unknown here, the Papuans cook their food with a little sea-water—generally one-third to two-thirds fresh water—and the inhabitants of the hills never omit to take away with them a bamboo filled with sea-water when they visit the coast. The Papuans have, nevertheless, a substitute for salt, for they collect the tree-trunks which, after soaking for a while in the sea, are cast up at high tides, dry and burn them, and thus procure therefrom a saltish tasting ash.

The manufacture of intoxicating drinks is, moreover, not unknown among the Papuans. They take the stem, leaves, and especially the root, of a certain shrub called "keu" (*Piper methisticum*?): this they chew, and the resulting mass, when sufficiently masticated, is spat out with as much spittle as possible into a cocoa-nut shell. A little water is added to this, and, after the dirty green-looking brew has been filtered through some grass, the filtrate, which is very bitter and aromatic, is drunk off. This liquor does not taste particularly good, as is proved by

¹ "Ethnologische Bemerkungen über die Papuas der MacLAY-küste in Neu Guinea." Reprinted from the *Naturkundig Tijdschrift* of Batavia.

² A small marsupial confined to New Guinea.

the grimaces of the natives as they drink ; very little, too, goes a long way, for a small wine-glassful suffices, in half an hour, to make a man unsteady upon his legs. Old people only are allowed to indulge, for it is strictly forbidden by custom to women and children. The Papuan *ken* appears to be identical with the *kawa* of the Polynesians, only these latter add more water.

The *cuisine* is in every way more elaborate than among the Polynesian aborigines, both as regards variety of dishes and the use of earthenware. Though food is mostly prepared with sea-water, the Papuans, nevertheless, know how to roast flesh or fish, or bake it, enveloped in leaves, in the ashes. As on account of the climate cooked food will not keep long, the Papuans either roast (e.g. in the case of the Collocasia and Dioscorea) on the morrow the remnant of that which is stewed to-day, or *vice versa*, as is the case with fish, which is fried immediately after it is caught, and stewed with vegetables on the following day. By this means the millions of mildew spores and mycelia which in a few hours invade and pervade all food, whether roast or boiled, are arrested in development, and so rendered harmless. The men help the women in the preparation of food ; in fact, on festal occasions and on the entertainment of an honoured guest, this is done entirely by the men alone. On ordinary occasions the husband cooks for himself alone, and the wife for herself and the children apart. The two sexes never eat at the same hearth, or out of the same dish.

The domestic utensils consist of earthenware pots of various sizes, and of wooden dishes. They are of the following varieties :—

Pots (*wab*).—These are usually of the same shape ; being almost round, and tending somewhat to a point at the bottom. They are made in a few coast villages and in the neighbouring islands, and, though generally prepared with great care, show but few ornamentations—these consisting either of straight lines, rows of dots, or small curves, evidently impressions of the nails. The mountain people do not understand this manufacture, and so must obtain their pots either by present or by barter.

The wooden utensils (*tabir*) consist of large round or oval plates and bowls, and seem very cleverly made, considering that the only tools used in their construction are either of stone or of bone. They are finally smooth polished with fragments of shells, and a black dye is then rubbed in. The “*tabir*” forms, with the weapons, the most important possessions and articles of barter for the Papuans.

The shells of the cocoa-nut (*gamba*) are used as plates by the lower members of a family, as it is only for the father of the family or for a guest that food is served in the large wooden bowls.

A kind of fork (*kassen*) is used at meals, consisting of a pointed stick. Three of these are sometimes tied together, and are then generally carried in the hair, as they also serve the purpose of head-scratchers.

The *kai* is a kind of spoon made from a cocoa-nut or mollusc shell ; while the *schiliupa* is made from a flat splinter of kangaroo or pig's bone, and can be used either as a knife or shallow spoon.

A very important implement—the *jarur*—is made merely from a smooth shell, in which teeth are cut with a stone. This is used to grate the albumen of the cocoa-nut, which is usually only eaten in this form.

The implements and arms are as follow :—“ If we look at,” says Maclay, “ their buildings, their pirogues (canoes), their utensils, and their weapons, and then cast our eyes upon the stone axe and some fragments of pebbles and shells, we must perforce be struck with astonishment, if only at the great patience and skill displayed by these savages.” The axe, which, though their chief implement, is, no one will deny, a tool simple enough, consists of a hard, grey, green, or white stone, which has become

smooth and sharp by long polishing. Hatchets have been seen by Maclay in the “ Archipelago of Contentment,” which were made out of a thick clam (*Tridacna*) shell, instead of from stone. A portion of the stem of a tree, which has a branch passing off at an angle, somewhat like the numeral 7, is hewn off, and upon the branch, which has been cut off short and shaven flat at the top, the stone is laid horizontally and bound fast with lianas or various kinds of tree-barks. Such an implement can only be used to advantage by one accustomed to handle it ; otherwise, either the stone is broken or nothing results. The aborigines, however, can with their axe, having a cutting edge of only two inches in breadth, fell a tree trunk of twenty inches in diameter, or carve with the same really fine figures upon a spear. Every village possesses a large axe or two having a cutting edge about three inches broad, and which is wielded with both arms, while the ordinary axe of two inches edge is employed with the right arm only. The stone of the hatchets, a kind of agate, is confined to the mountain people, and is not found in superfluity. Each adult is in possession of only one good axe, the large ones being kept by their owners as things of the utmost value and rarity.

Fragments of flints and of shells are used to put the finishing touches to work done in the rough with the stone axe, the shells being preferred to the flints, as being not so brittle. All sorts of devices can be carved upon bamboo with shell fragments. The great combs of the Papuans and the bamboo boxes in which the lime for betel-chewing is kept, as well as their arrows, furnish instances of this art.

The *dongan* is a pointed or flatly split bone, having the shape either of a dagger or of a chisel. For the first-named pattern the bones of the cassowary and (but rarely) those of man are used, while those of pigs and of dogs are employed for the latter form. The “*dongans*” are used for cutting either raw or cooked fruit, and are generally carried on the arm, being supported by the arm-ring.

A knife is made from the bamboo by removing the inner woody fibres at the edge of a fragment, so that only the sharp siliceous outer part is retained. With this, meat and fruit and vegetables are cut up, while the *dongan* is never used for cutting, but only for splitting and piercing.

The weapons comprise—

1. The *chadga*, a spear used for throwing, about 6 ft. 8 in. in length, and made of a hard, heavy wood. It is the most dangerous and most universally used of the Papuan weapons.

2. There is also a longer, but lighter, spear, the *serwaru*, tipped with a sharpened piece of bamboo, which, after a victim has been struck, breaks off from the shaft and remains in the wound.

3. The *aral* is a bow, about two yards long, the string of which is made from bamboo.

4. The arrows, *aral-ge*, are about one yard long, of which the tip is as much as a third or a quarter of the shaft in length, and is sometimes provided with barbs.

5. A most dangerous kind of arrow, *patom* by name, is of the same size as the preceding, but resembles the *serwaru* in having a broad bamboo tip. For catching fish there is yet another variety of arrow, the *saran*, provided with four or five points. When fishing by torch-light, the Papuans use the *jur*, a harpoon with numerous tips of hardened wood, and furnished, in order that it may not sink, with a bamboo shaft.

The inhabitants of the neighbouring islands—*Bili-Bili*, *Jam-Bomba*, *Griger*, *Tiara*, &c.—possess in addition large shields, about a yard in diameter, made out of a hard wood, and ornamented with carvings. Miklucho Maclay's coast neighbours had nothing of the kind. In some of the villages he saw long flat sticks, about a yard

and a half in length, which must be wielded, much like the large ancient swords, with two hands.¹

Slung-stones are also in use in time of war. The principal weapon of warfare, however, is the above-mentioned *chadga*, which is dangerous up to a range of from thirty-five to forty paces. The arrows can scarcely be considered dangerous above fifty paces range, because they are too light. In war time, and in hog-hunting, the tips of the spears and arrows are rubbed with a red earth, but the Papuans in this neighbourhood do not poison their arrows.

Regarding the dress and ornaments of the Papuans: the sole article of clothing of the men is the *mal*, a kind of cloth prepared from the bark of trees, having a length of more than three yards and a breadth of about a quarter of a yard. This article of dress is manufactured in a way similar to that of the *tapas* of the Polynesians; the outer layer of bark is detached, and then beaten with a piece of wood upon a stone until it becomes soft and supple, after which it is dyed with a red earth. It is worn thus: one end having been held fast on the belly, at the navel, the cloth is passed between the legs, and then carried several times round the waist, the end being finally tied with the first end in a knot at the back. As much traction is exercised upon the part which is pushed between the legs, the anterior end comes to hang down in front. The corresponding dress of the females, also called *mal*, consists of fringes about half a yard long, fastened to a girdle, which hangs down in thick clusters as far as the knees, and does not embarrass the movements of the body. This garment is generally dyed in black and red horizontal stripes. In some villages the *mal* of the girls up to the time of marriage consists of a girdle, to which two bunches of dyed bast are attached, one hanging down in front, the other over the middle of the buttocks; and when they sit down they carefully pull the hinder and longer bunch between the legs. These young ladies also carry on either side of their buttocks ornaments of shells and coloured fruit-stones. Besides the *mal*, the Papuans possess long and broad pieces of cloth, similarly prepared, which they wear over the shoulders in the night and early morning, as a protection against cold.

The ever-constant companions of the Papuan are his *jambi* and his *gun*. The former is a small bag carried round the neck, containing tobacco and various small articles; while in the latter, which is larger, and is slung over the left shoulder, he carries a box of quicklime for betel-chewing, his *jarur*, *schiliupa*, and *kai*, shells, and bamboo boxes containing red and black dyes, and other necessities. These bags are woven out of variously coloured threads, and ornamented with shells.

The men carry on the upper arm, above the biceps, bracelets called *sagin*, artfully woven out of bark or grass, and ornamented with shells. Stuck in such a ring the *dongan* is carried. Similar rings, or "bangles"—*samba-sagin*—are worn above the calves. A highly prized ornament, worn hanging from the neck over the breast, is the *bul'ra*, wild boar's tusk.

The men also wear broad earrings of turtle-shell or of wood, or in default of these, pieces of bamboo, longish stones, or flowers. The women have two kinds of earrings. From either ear-lobe hangs one or several rings; or from the upper edge of one ear there passes a cord across the forehead to the corresponding part of the other ear, while from either extremity of the cord a bundle of white dogs' teeth hangs down on the side of the neck. The women also have two bags—*nangeli-gun*—which are much larger than those of the men, and are carried on the back, slung by a band round the forehead. In one of these fruit is brought daily from the plantations into the villages, while in the other the newborn children, or else young pet pigs or puppies, are carried. J. C. GALTON

(To be continued.)

¹ Could these not be used, like similar weapons employed by certain tribes in the "heart of Africa," for parrying blows?—J. C. G.

THE MUSEUM OF COMPARATIVE ZOOLOGY, CAMBRIDGE, U.S.A.¹

THE Report of the Museum of 'Comparative Zoology for the past year, which has just reached this country, is of great interest, as it gives us an account of the way in which the supporters of this noble Institution have endeavoured to meet the blow it suffered by the premature death of its founder. The Penikese School of Natural History succumbed, we know, after a faint struggle, but it does not at all appear that the Museum of Comparative Zoology is likely to follow its example. A fund of 260,600 dollars has been raised by public subscription, as a memorial to Agassiz, which is to be devoted to the completion and endowment of the Museum, and the State of Massachusetts has granted a further sum of 50,000 dollars to the like object. As more than the amount, stated to be necessary for the purpose has thus been received we trust there can be no doubt that the desired object will be attained, and the building finished and its staff endowed according to the plans formed by the late Professor Agassiz.

The general work of the assistants in the Museum of Comparative Zoology during the past year, has we are told, "as usual consisted mainly in preparing materials for exhibition, and packing the duplicate collections for exchange." The late Professor Agassiz accumulated, as is well known, enormous masses of specimens of every class in alcohol. But the present Report says:—

"The great difficulty of preserving alcoholic collections, the unpleasant nature, and enormous expense of the work make it imperative, not only for storage, but still more for exhibition purposes, that they should be restricted to a minimum, and limited, as far as possible, to those classes where no other mode of preservation is practicable. The constantly increasing facilities of travel, the comparative economy with which fresh specimens can be studied, the superiority of such work (with proper appliances) to that of the Museum, the daily increasing number of workers who are able, on the sea-shore or in the field, to produce results unattainable by Museum study alone, show that the time has come when large collections must naturally be supplemented by zoological stations. These, when once established at properly selected localities, will enable Museums to dispense with much that is now exceedingly costly. They will become, for certain departments at least, chiefly depositories where the record of work done at the stations—the archives of natural science, so to speak—will be preserved; so that, while their usefulness for the general instruction of the public and of our higher institutions will not be diminished, they must hereafter be useful to the original investigator in a somewhat more limited field."

There can be no doubt of the sagacity of these remarks. They should be well considered by the supporters of the Aquariums now springing up in every direction, which might easily be so arranged as to be useful also as Zoological Stations like that at Naples.

The most important addition made to the collection at Cambridge in 1875, appears to have been that formed by Mr. Alexander Agassiz during his expedition to Peru and Bolivia. This, we are told contains a "fair representation of the Fauna of the high plateau in which Lake Titicaca is situated." A preliminary account of the materials collected is now being published in the "Museum Bulletin." The fishes and reptiles will be described by Mr. German, the fossils by Prof. O. A. Derby, the crustacea by Mr. Faxon, the birds and mammals by Mr. Allen, and Mr. Agassiz hopes, himself, to be able to give a short account of the physical geography and geology of the district.

¹ Annual Report of the Trustees of the Museum of Comparative Zoology at Harvard College, in Cambridge; together with the Report of the Curator to the Committee of the Museum, for 1875. Boston, 1876.

Thanks to the generosity of the Pacific Mail Steamship Company in passing the baggage free, Mr. Agassiz and his companion took to Peru a large outfit in the way of ropes, dredges, sounding-leads, thermometers for deep-water temperatures, and all the necessary materials for preserving large collections.

Though they were greatly disappointed in the variety of animal life found in the lake of Titicaca and the surrounding shore, they took some very interesting deep-water temperatures (to a depth of 154 fathoms), and completed a preliminary hydrographic sketch of the Lake, which has furnished valuable results, and done much to explain the poverty of its animal life.

The success of the Memorial-fund, of which we have spoken above, will, it is anticipated, enable the principal ideas of the late Professor Agassiz to be accomplished, so soon as the necessary additions to the buildings are completed.

"The foundation will then be laid of an institution in which the claims of college-students, of teachers, of special students, of advanced workers, and of original investigators will be considered, as far as the means and space of the establishment will allow. The public will find in the exhibition-rooms all that is likely to be of interest from the stores of the institution, labelled and arranged so as to be not only instructive, but suggestive.

"Of course time alone will enable us to fill out and complete this plan. We shall be compelled at first to make a very unequal exhibition, but as the blanks become apparent they will be filled.

"From our stores necessary materials for the constantly increasing number of students are to be supplied, and one of the chief duties of the Curator must always be to meet the reasonable demands of those charged with the instruction, by supplying them with ample materials suited to the wants of the different classes engaged in study at the Museum. The special students will have at their command, under proper regulations, in the store and work-rooms, of the assistants, the materials of the department in which they are interested.

"To the original investigator the resources of the Museum will always be available, under generous restrictions, with facilities for the publication of investigations made with Museum materials, as far as the means of the institution will allow. On the completion of the additions proposed at present, the Museum will thus consist of several departments of natural history, formerly separated in the University, and now all more or less intimately connected."

In concluding our notice of this report, we shall, we are sure, be heartily joined by every European naturalist in wishing that these excellent plans of the Director of the Museum of Comparative Zoology may be speedily and efficiently carried out.

THE GREENWICH TIME SIGNAL SYSTEM¹

II.

WE have now to speak of the use made of the time signals beyond the Observatory walls, and will first refer to the hourly currents passing to the Post Office. The original time-distributing apparatus was comparatively simple; afterwards Mr. C. F. Varley devised the chronopher, an elaborate system of switches and relays provided with an accurate clock for opening and closing the switches at the proper times, and forming together a complete automatic system; but on the transfer of the central telegraph station from Telegraph Street to the new building in St. Martin's-le-Grand, it was found necessary to add a second and much larger chronopher, shown in the accompanying drawing. It is to this apparatus that the Greenwich wire is led, and by which the single Greenwich

current is simultaneously retransmitted on many different lines. These lines may be considered as divided into four groups:—1, the metropolitan; 2, the short provincial; 3, the medium provincial; and 4, the long provincial. The first group consists of wires passing to points in London; the second of wires passing to towns within a moderate distance of London, as Brighton, &c.; the third of wires passing to greater distances, as Hull, &c.; and the fourth of wires passing to towns or places at a considerable distance, as Belfast, Edinburgh, Guernsey, &c. In each of the four groups the London ends of the several lines are brought into direct connection, each group having its separate battery and relay. On these four relays (the two at the left hand and two in the centre of the six shown) the current from Greenwich acts, and in each relay circuit the local battery current so divides that a portion of it passes out on every wire of the group.

The distribution in London takes place every hour; these wires, being used for time-signal purposes only, remain always connected to the metropolitan relay. To the country, distribution is made twice only on each day, at 10h. A.M. (by the new chronopher), and at 1h. P.M. (by the old chronopher), using the wires of the ordinary telegraphic service, which have, in consequence, to be specially switched into connection with the chronopher. The action at both hours is similar; we shall therefore describe only the 10h. A.M. distribution, which is the more extensive. Shortly before 10h. the chronopher clock (not shown in the sketch) sets in motion the clockwork train shown in the centre of the drawing; this turns over on its axis the flat bar (extending from side to side across the row of upright springs), which pushes the springs backwards, each one out of contact with its corresponding little square stud above. Each spring is in connection with a distant town or telegraph station, the corresponding stud communicating with its particular speaking instrument in the London office. As soon, therefore, as the springs are pushed back, the speaking instruments become all cut off, and the springs (representing distant stations) remain in contact with the long bar. This bar consists of three insulated portions, one for each of the three groups of provincial wires, each having its own battery and relay as before mentioned, and when it comes into contact with the springs in the way described, the distant stations all receive a constant current which serves as warning. On arrival of the Greenwich current at the chronopher the relays act and reverse these battery currents, and these reversals of current indicate at the distant stations the hour of 10h. A.M. precisely. Shortly after 10h. the clock-work train causes the long bar to turn back into its ordinary position, the springs become restored each to its respective stud, bringing the lines all into communication with their several speaking instruments, and the ordinary telegraphic work goes on as before. Of two relays on the right in the drawing, one (by action from the chronopher clock) opens out the relay coils a few seconds only before the hour, and so prevents interruption from accidental currents in the Greenwich line; the other is concerned in the Westminster clock signalling, spoken of further on. The galvanometers are for showing the passage of the various currents of which we have been speaking.

In some cases the current drops a time-ball on the roof of a building, in others a model time-ball is exposed to view in some place accessible to the public; sometimes the current acts on an electric bell, or ordinary galvanometer, and in some cases a gun is fired. The last-mentioned manner of communicating time to the public is one of the most generally useful for ordinary purposes, provided that the observer makes allowance for the rate at which sound

¹ It is to be remarked that although the signals pass into Ireland, Greenwich time is counted only in Great Britain, Dublin time being counted throughout Ireland. In regulating clocks in Ireland by the Greenwich signals, allowance has therefore to be made for the constant difference between Greenwich time and Dublin time.

² Continued from p. 52.

travels (about four miles in nineteen seconds). Time-guns are thus automatically discharged at 1 P.M. daily at Newcastle, Sunderland, Middlesboro', and Kendal.

The action of the apparatus, both at Greenwich and in the Post Office, is entirely automatic. Still, in the extension of the system, inquiries have sometimes been made as to the degree of exactness of signals received through the chronopher; the accuracy of its transmission has therefore been tested by direct experiment. One of its distributing wires was connected to a wire returning to Greenwich, so that the current leaving the Royal Observatory to act on the chronopher could be directly compared with that received at Greenwich from the chronopher. The currents were made to pass through galva-

nometers placed side by side, but there was no sensible difference in their indications. It follows, therefore, that entire confidence can be placed in the distribution by the chronopher.

As showing the extent to which demand for the automatic chronopher signals has increased, it may be mentioned that for some years past the *British Postal Guide* has contained a tariff of annual charges for which the telegraph department will supply such signals and maintain the special connecting wires, both in London and the country.

The automatically transmitted signals are scientifically accurate, but a very extensive practical distribution of time is also made daily at 10 A.M. by hand contact. In

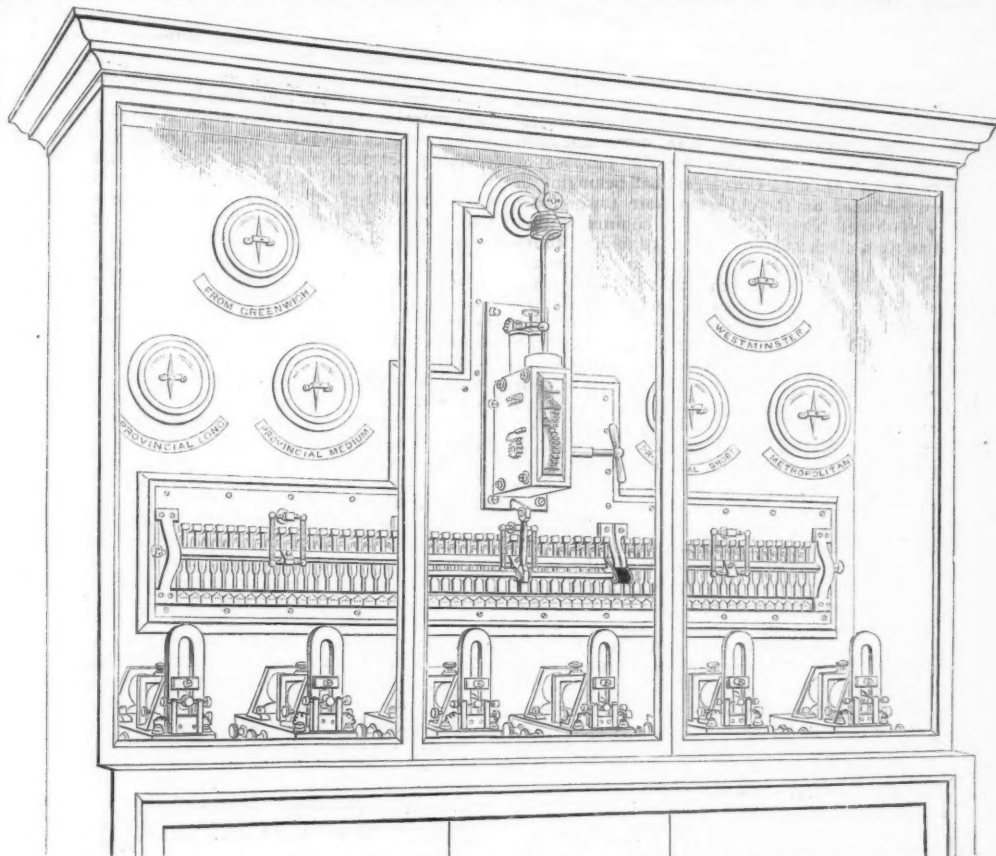


FIG. 2.—New Chronopher (or time distributing apparatus) in the Central Postal Telegraph Office, St. Martins-le-Grand.

the large instrument room of the central telegraph station a "sound" signal is established in connection with the chronopher. When heard at 10 A.M., the clerks, being in readiness, immediately transmit signals by their ordinary speaking instruments to above 600 offices in direct communication with the central station, including those in towns not supplied from the chronopher, the London offices, and the principal London railway termini. At many of these offices the signal is redistributed to others radiating from them, and so practically regulates most of the post-office and railway clocks of the country—these in their turn, insensibly as it were, regulating the clocks of the surrounding districts.

Thus, either by the accurate chronopher signal, or by

the arrangement spoken of in the preceding paragraph, the 10h. current each morning from Greenwich, through the Post Office telegraph system, gives time simultaneously in all parts of the United Kingdom.

One of the chronopher lines in London passes to the clock-tower of the Westminster Palace, and hourly signals are received at the clock for its necessary rating and adjustment. It is, however, in no way controlled or mechanically acted upon by the time currents. Practically, the clock requires to be very rarely touched; if change becomes necessary, it is usually made by adding to or removing from the pendulum small auxiliary weights. The clock also completes a galvanic circuit at a certain time daily, and so transmitting a signal, reports

its rate at Greenwich. The statement of the Astronomer Royal in one of his annual Visitation Reports, that the rate of the clock "may be considered certain to much less than one second per week," does not, we believe, overestimate its performance. As regards its absolute variation from true time, we find, according to his last report, that on 83 per cent. of the days of the preceding year its error was below one second. We may mention that the clock has a gravity escapement, that the compensation of the pendulum is entirely metallic and generally similar to that of the Greenwich Sidereal Standard (described in our article on that clock), and that the first blow on the bell at the hour is true clock time, it having been made a condition in the construction of the clock that there should be no loss of time in the first stroke.

So far as regards the work done from one of the wires passing from the Royal Observatory: on the other, terminating at London Bridge, currents also pass from Greenwich hourly, which, with the exception of that at 1 P.M., are placed at the disposal of the South-Eastern Railway Company, who in return give to the Royal Observatory, for two or three minutes daily at 1h., communication between London Bridge and Deal for the purpose of dropping at the latter place a time signal ball belonging to the Admiralty, placed on the old semaphore tower (part of the now abolished Navy Yard). For communication with Deal at 1h. a clock at London Bridge (one of those before spoken of as being controlled from Greenwich) automatically switches the Greenwich wire into communication with a wire on the main line of the South-Eastern Railway. Other special connections are also daily made at Ashford and Deal before the current can pass uninterruptedly from the Observatory to the time-ball; immediately after 1h. the wires are restored to their former positions. To ensure that the ball has fallen properly at 1h., an arrangement exists by which, after its discharge and before it has completed its descent, it makes such momentary changes of the wire connections as cause a "return" signal to pass to Greenwich indicating that it has fallen. This ball was established by the Admiralty to give Greenwich time to shipping in the Downs, and has been in use since the year 1855. It is placed under the superintendence of the Astronomer Royal, who in his annual Visitation Reports gives statistics by which we can judge of its practical working. Examining these reports for the last few years we find, on the average, that about once in two months the ball was not raised on account of high wind, and that about once in six weeks, from accidental telegraphic fault, there was no discharge. An erroneous drop appears to be rare, happening once or so in a year. When such does occur, a black flag is at once hoisted as indication of mistake, and the ball is then dropped at 2h. The efficient working of the ball, thus distant from the Observatory, is considered by the Astronomer Royal to be mainly due to the establishment of the return signal which immediately makes known at Greenwich whether the ball has fallen in the usual way.

Excepting the 1h. current, used as described for the Deal ball, the remaining hourly currents to London Bridge are distributed by Mr. C. V. Walker mainly on the lines of the South-Eastern Railway. For this distribution the clock at London Bridge, already spoken of, switches at different hours different wires into connection with the Greenwich wire, and so passes on the Greenwich current; at some hours it goes to the office of the British Horological Institute in Clerkenwell, for the use of watch and chronometer makers.

It will be seen that the country generally is well served by the system now described, but a useful extension would be made by the establishment of authoritative signals in favourable positions on our coasts, for the purpose of giving to mariners the means of obtaining Greenwich time and approximate sea rates for their chronome-

ters after leaving port. One coast signal only at present exists—the time-ball set up at Deal, as already described. Some few years after its erection, however, it was suggested that a time-signal should be also exhibited every hour at some headland of the southern coast, and after some discussion of localities, the Astronomer Royal proposed a detailed scheme for showing such signals on the Start Point. And more recently the Shipowners' Association of Liverpool made inquiry as to the facilities for exhibiting a similar hourly signal on the Tuskar Rock. Neither of these schemes has yet been carried into execution, but, excepting the question of cost, there seems to be otherwise no difficulty.

It was indicated in an early part of our article that one of the objects of connecting the Greenwich Observatory with the telegraphic system was the possible determination of differences of longitude between Greenwich and other observatories by the exchange of galvanic signals, and since such connection has existed, many important determinations of the kind have been made. We cannot here enter into any detailed description of the different plans that have been from time to time employed in practically carrying out such operations: it will be sufficient to say that the longitudes of the principal British and of some continental observatories have been thus determined. On two occasions Atlantic cables have been employed for fixing the positions of points in America, and more recently (in connection with the Egyptian expedition for observation of the late Transit of Venus) the longitude of Cairo has been by similar means determined. In the latter operation signals were exchanged between the submarine cable stations in Cornwall and Alexandria with perfect success, through one unbroken line of submarine wire. The telegraphic method of determining longitude is one of the most accurate that can be employed.

The connection of the Royal Observatory with the telegraph assists scientific inquiry and even commercial enterprise in various unexpected ways. Capt. Heaviside, R.E., having recently been engaged with some pendulum experiments at the Kew Observatory, it only became necessary to connect the telegraph line at Greenwich to the Sidereal Standard for a few minutes daily, to enable him to receive seconds signals through the Post Office wires, and so refer his observations directly to the Greenwich clock. Also, in the laying of Atlantic cables, an accurate knowledge of Greenwich time being of the greatest importance for the exact navigation of cable ships, Greenwich time has on such occasions been daily passed from the Royal Observatory through the cable itself, as it was being submerged, to the ship.

Our object has been simply to describe the Greenwich system, but we may mention that the plan of telegraphing time, first carried out at Greenwich as part of the daily routine, has since been adopted in other places. In Britain much has been done at the observatories of Liverpool, Edinburgh, and Glasgow, for the dissemination of a knowledge of accurate Greenwich time, both by public clocks and public signals, in the vicinities of those cities. A time-gun is fired daily both at Liverpool and Edinburgh by signal from the observatories of those places. Time-signal systems in connection with observatories are also in operation in various of our colonies, and in places abroad. In the United States of America several very extensive systems have of late years been established, and it has recently been proposed to regulate the clocks of Paris from the Paris Observatory.

The system of employing the ordinary telegraph service of a country for the daily transmission of time in many directions from a fixed observatory shows the benefit that may sometimes ensue from uniting for a special object the powers of two separate institutions of totally different character. The astronomer must for his own particular work obtain from the face of the sky that which, especially in our day, is also so useful to mankind, an accurate

knowledge of the flow of time. This he can, with slight additional trouble, communicate to the external world, although wanting the means of promulgation to any great extent. Telegraphs, on the other hand, exactly supply this want, and can spread abroad in all directions the astronomer's information. Before the transfer of the telegraphs to the State, the successful working of the Greenwich system was due entirely to the existence of amicable arrangements entered into by both parties. But now that the time-signal system is, as it were, consolidated, it might well receive greater development. The principal clocks, and those of public institutions, in our large cities and towns, London included, should be more directly regulated than is at present the case by the automatic signals which can be so readily supplied by telegraph, and which might usually be received (as at Westminster) in the clock tower or chamber, for direct comparison with each particular clock. In large towns one wire could be made to serve for many buildings, and the cost for each thus greatly reduced.

The efficient regulation of public clocks in the way mentioned is however a thing entirely for the consideration of the municipal bodies in the various cities and towns concerned. But it is otherwise with the question of the establishment of signals on our coasts for the giving of Greenwich time to outward-bound or passing vessels. This is a matter not merely of local, but of national interest; and, since the whole subject of the safety of our ships at sea is now under the consideration of the Imperial Legislature, it seems a proper time to direct attention to the usefulness of such coast-signals, as tending directly to the improvement of navigation, and thereby contributing in an important degree to the further protection of shipping.

MIGRATION AND HABITS OF THE NORTHERN WEGIAN LEMMING

WITH all our recent knowledge of the Northern Fauna, and the ample opportunities of the Scandinavian naturalists, the animal in question still seems to have evaded a thorough scrutiny and complete solution of the why and wherefore of its remarkable migrations. Ten consecutive summers spent in Norway have led Mr. W. Duppá Crotch,¹ in studying the creature, to propound a novel view as to the impetus of its recurrent irruptions. Passing by the traditional lore respecting its sudden appearance in myriads, he discountenances the later informed writers' explanation of hunger, or of the approach of severe weather, being the cause. Even "survival of the fittest," with its cogent subsidiary clauses, according to our author, fails to serve as a substantial reason, for, as he observes, none of the travellers survive. His own theory is a very simple one. The bands of migrants always head westward, and at last, in diminished numbers, perish in the sea. In one well authenticated instance (Collet), a ship sailed for fifteen minutes through a swarm, the water being literally alive with them far as the eye could reach. This migratory instinct, Mr. Crotch assumes, is hereditary, their progenitors in the good old times of geological age having sojourned in a land of plenty, now submerged beneath the Atlantic. According to him the migration is not all completed in one year, as formerly supposed, nor do they, as stated, form processions and cut their way through obstacles; but breeding several times in the season, they gather in batches, and at intervals make a move westward. Their pugnacity, he states, is astonishing, and the approach of any animal, or even the shadow of a cloud, arouses the anger of this small creature like a guinea-pig, and they back against a stone or rock uttering shrill defiance. Our author found, in most examples, a bare patch on the ramp, due to their rubbing against the said buttress of

support when at bay. He wonders why a bare patch, and not a callosity, should not result from this innate, apparently hereditary habit. They cross wide lakes by swimming, but when in the water they are easily frightened, and lose all idea of direction, and are inevitably drowned by a slight ruffling of the surface. It seems the reindeer trample them under foot whenever the chance may occur, and other enemies in the shape of hovering rapacious birds and small carnivora thin the numbers considerably as the Lemmings in force drive westward. The writer also called attention to the fact that fossil remains of the Lemming exist in England, as an evidence that the animal had penetrated hither before this island was severed from the continent. The subject altogether is a most interesting and suggestive one, well worthy of the investigation and observation of northern sojourners. Even the recent views of Mr. Crotch, it seems, does not set the whole question at rest. There possibly may be some physical or physiological reason underneath; at all events it is certainly remarkable how a settled westward course is that chosen, calling to mind the similar direction which races of men are assumed to follow.

THE SEYCHELLES ISLANDS¹

THE Report mentioned below is dated 20th May, 1875, and refers to two visits made to the Islands of the Seychelles group in 1871 and 1874. The islands visited by Mr. Horne were Mahé, Praslin, Silhouette, La Digue, Félicité, Curieuse, Aux Frégates, St. Anne, and Aux Cerfs. The soil, climate and products of the islands are very similar, so that the remarks made are equally applicable to all of them. The climate is healthy, although the islands are situated almost under the equator, and the Cascade Valley in Mahé which is at an elevation of 1,500 feet above the sea, is pointed out as being especially delightful. The seasons are two, the warm and wet, during the north-west monsoon, from October to April; and the comparatively cool and dry season from April to October. The rainfall during the year is about 96 inches, most of which falls during the wet season.

Some of the islands have high mountain peaks, as Mahé, with an elevation of 3,000 feet, and Silhouette with an elevation of 2,500 feet; the highest land in the other islands is less than 1,500 feet. Lagoons often exist between the base of the mountain and the flat sandy beaches which exist in all the islands. In former times crocodiles were abundant in the lagoons, but they have now been extirpated.

The islands are granitic with veins of trap. Coral reefs are abundant but of small size, the largest being on the north-east of Mahé, and the north-east and south-west of Praslin. The surface of the islands is mountainous and undulating. Granitic boulders are common, and are most numerous near the mountain tops and in the bottom of ravines. The soil is rich and capable of producing any kind of crop peculiar to the tropics. In many places, however, the soil has been washed away, and some of the islands are almost bare rock. There is much uncultivated land, the greater proportion of which is good, but according to Mr. Horne, the people are either too lazy or too poor to cultivate it.

The chief produce of the islands is cocoa-nut oil and fibre. The plantations of cocoa-nut palms are increasing, and many of the young plants are now bearing, which they do when ten or twelve years old. The value of a plantation in full bearing is about three shillings per tree per annum. The oil is extracted by the old primitive mill which has been used in Ceylon and elsewhere for hundreds of years. The fibre is extracted by machinery and will soon

¹ Report on the Seychelles Islands. Addressed to the Honourable the Colonial Secretary, by J. Horne, Sub-Director Royal Botanical Gardens, Mauritius.

² In a paper read before the Linnean Society, May 4.

form an important item in the exports from the country. The cocoa-nut thrives very well in the Seychelles, and plantations exist from the sandy beaches up the slopes of the mountains to elevations of from 1,000 to 1,500 feet. Tobacco was formerly much cultivated, and was of very fine quality, but the imposition of a tax on tobacco seems to have stopped the cultivation, and Mr. Horne says "the value of the tobacco grown would scarcely suffice to pay the tax, independently of the return which might be expected for their labour." Sugar-cane is cultivated to a small extent to make rum, but although the canes are magnificent, the yield of sugar is small and unremunerative. Cotton also grows remarkably well, but the cultivation has died out since the abolition of slavery, owing to the want of labour during the picking season. The chocolate plant grows freely on waste lands, and its culture is progressing. Vanilla has been planted in several places, and these plantations will shortly be bearing.

Maize and rice are but little cultivated, although in some places two crops of the latter might be obtained each year.

Spices, as cloves, cinnamon, nutmegs, allspice, and pepper thrive well. Clove trees are abundant and attain a height of 40 to 50 feet. The islanders gather the cloves in a reckless and extravagant manner, often felling the trees when the cloves might be reached by a bamboo ladder. The cinnamon is the bitter cinnamon, and is comparatively worthless. The nutmeg and allspice trees were introduced in 1871, and here thrive well. Pepper (*Piper nigrum*) is abundant, climbing over the granite boulders like ivy, and much might be made of it if a few Chinamen or Malays were introduced. Vegetables are very scarce, chiefly from the indolence or indifference of the inhabitants. Manioc and sweet potato are abundant, but yams are very little cultivated. The inhabitants obtain most of their food from the *Colocasia esculenta*. Arrowroot has been planted, and ginger, turmeric, and cardamoms might be easily cultivated. Mr. Horne recommends the rearing of silkworms and the cultivation of coffee. Mulberry-trees grow very readily, and coffee seems formerly to have been cultivated. The only drawback seems to be the want of labour. Pine-apples are abundant but of inferior quality, while oranges are common and excellent. Limes and bigarades are not uncommon, and lime-juice was formerly manufactured to some extent. Other tropical fruits, as ananas, bread-fruit, &c., are common.

During Mr. Horne's two visits he collected about 400 species of plants. About half that number are plants inhabiting all tropical countries, the greater portion of the other half will find congeners in Madagascar, Eastern Tropical Africa, Southern India, the Malay, Polynesian, or Oceanic Islands. The Flora of the Seychelles has no affinity to that of the Mauritius, and Mr. Horne considers that the relations to the Flora of Madagascar will be important from the similarity of geological formation and climate. He also thinks that the Seychelles Flora will have much in common with that of Eastern Tropical Africa. Mr. Horne's specimens have been sent to Kew, and will doubtless be described in the forthcoming Flora of Mauritius and the Seychelles. The Flora seems small, but vegetation is in many places scarce, owing to the occurrence of fires and from the ravages caused by the reckless felling of trees. Much of the ground is covered with dry Palm and Pandanus leaves, which easily take fire. The fire-tracks are readily distinguished by the age of the trees and shrubs now found growing on them.

The palms of the Seychelles are very interesting. The first is the Coco-de-Mer or Double Cocoa-nut. It abounds at Praslin, in a ravine, the highest trees measuring from 80 to 90 feet. The tree growing near the Government House at Port Victoria has flowered for the first time at about its thirty-fourth year. The other native palms of

the Seychelles are all spiny, viz., a species of *Areca*, *Stevensonia grandifolia*, *Verschaffeltia splendida*, the "Latanier Haubbaum," and another undescribed species. *Areca rubra* (?), *Hyphane* sp., and *Latania rubra* or *Borbonica*, have probably been introduced.

Articles, as hats, &c., of almost infinite variety are made from the young leaves of the Coco-de-Mer. The leaves of *Stevensonia* are used for thatch, and the split stems of *Verschaffeltia splendida* make excellent palisades. Ropes are made from the leaves of *Curculigo Sechellarum*, and fibre for cordage is got from *Paritium tiliaceum*. The fibre of *Fourcroya gigantea* (recently introduced) is made into fishing lines. The gum copal of Madagascar is got from *Hymenaea verrucosa*, a rare tree in the Seychelles.

Many useful timber trees are met with. The chief are the following:—

- "Capucin," a species of *Sideroxylon*.
- "Takamaka" (*Calophyllum inophyllum*).
- "Bois de Fer," a species of *Dipterocarpea*.
- "Gayac" (*Azalia bijuga*).
- "Badamier" (*Terminalia badamia*).
- "Bois de Natte" (*Imbricaria petiolaris*).
- "Bois Marée," a species of *Gomphandra*.
- "Bois Rouge" (*Wormia ferruginea*).
- "Bois de Table" (*Heritiera littoralis*).
- "Sandal," a species of *Rubiaceae*.
- "Bois Montagne" (*Campanospermum Zeylanicum*).
- "Cèdre" (*Casuarina equisetifolia*).

Mr. Horne carefully describes the uses of these timber trees.

The ordeal nut of Madagascar (*Tanghinia venenifera*) is met with in the Seychelles. It is a small tree about twenty feet in height, with large clusters of pretty white flowers having a pink centre.

Pigs are fed on the boiled roots of the *Colocasia macrorrhiza*; all parts of the plant are poisonous if unboiled.

Pitcher plants, *Pandani*, and species of *Loranthus* are common; Ferns are tolerably numerous, and include the *Cyathea Sechellarum*, *Angiopteris evecta*, &c.

Mr. Horne recommends the Government to purchase the Coco-de-Mer ravine, to prevent the destruction of the trees, and he very properly adds, that "the destruction of the trees would be an outrage on science and a disgrace to civilisation."

Trees seem to be felled quite indiscriminately—a portion of the tree selected, the rest left to rot—so that now good trees are only to be found in the most inaccessible parts of the mountains. We trust that Mr. Horne's report will not be overlooked by the authorities; otherwise we may soon expect to hear that the Seychelles are merely barren rocks and every trace of vegetation gone.

W. R. M'NAB

THE LOAN COLLECTION CONFERENCES

SECTION—PHYSICAL GEOGRAPHY, &c.

Opening Address by the President, John Evans, F.R.S.

IN opening the Conferences in connection with this Section of the Loan Exhibition of Scientific Apparatus, it will probably be expected that I should say a few words, if only by way of explanation, of the class of subjects that come within our range, which indeed are neither few nor unimportant. Let me first take the general list of subjects which have on the present occasion been grouped together, and which may be said to constitute our domain. These are Meteorology, Geography, Geology and Mining, Mineralogy, Crystallography, &c. Some of these subjects might no doubt with almost equal propriety have been assigned to other sections. Meteorology might for instance have been classed under the head of Physics and Mineralogy would not have been altogether alien to

the Section of Chemistry. There is, however, so close and intimate a relation between all the various branches of physical research, that it is not only difficult to draw exact boundaries between their provinces, but also to determine to which group any given province shall belong when it becomes necessary to map out the whole field of science into some four or five divisions.

Our province may be regarded in the main as comprising the physical history of the earth—the constitution of its mineral parts and the forms and characters they present when crystallized, the geological succession and nature of its component rocks; the past and present distribution of land and water, and the causes which have led to its modifications; and lastly those meteoric influences which not only affect climate, but are active causes in the carving out of the earth's surface and in the redistribution of the materials of which it is composed. Nor do we only take the purely scientific and theoretical portions of our subjects, but also the application of scientific principles to produce economic results, and to lessen the dangers of those who in the exercise of their calling meet the forces of nature under some of their most destructive aspects.

It is of course only with the apparatus which has been devised for the purpose of carrying on the investigations into the physical history of the earth, and the applications of scientific principles which I have just mentioned, that we are mainly concerned, and not with abstract questions relating to any branches of science. It may, however, be found necessary to enter more or less into such abstract questions if only to show the character of the investigations which have to be pursued, and to elucidate more fully the difficulties with which inquirers have had to contend, or which still have to be conquered. Such questions may also have to be discussed should the history of the gradual development of some of our modern appliances be gone into. Some of the earlier forms of instruments which are now exhibited are indeed of great interest, whether they are regarded in the light of what may be termed milestones on the road of scientific progress, or as memorials of the eminent men by whom they were devised or used. The goniometers of Haüy and Wollaston, the nascent safety-lamp of Davy, the blowpipe of Plattner, the barometer of De Luc and H. B. de Saussure, the thermometer of Gay Lussac, the geological maps of William Smith, the logbooks of Cook, Franklin, and Parry, the instruments and maps of Livingstone, are replete not only with scientific but historical interest.

It is, indeed, as constituting an epoch in the history of scientific discovery, that such a collection as that among which we are now assembled has its highest value and interest. The third quarter of the nineteenth century has just come to its end, and we may venture to compare the advances which have been made during the last twenty-five years not only in our own particular walks of science, but in every branch of it, with the advances which had been made during the previous quarter of a century, the close of which was marked by the first Great Exhibition held in London. Great as had been the progress in scientific knowledge and in the application of scientific principles during that second quarter of the century, and favourably as it contrasted with the by no means despicable attainments of the previous quarter, the advances made during the last twenty-five years both in our knowledge of the principles of the great forces of nature and in the accuracy and delicacy of our instruments for their investigation are such that the present generation has at least no cause to be ashamed of them. Possibly when another quarter of a century has elapsed, those who come after us and those among us who survive as labourers in the field of science, may look back upon some of the processes now in vogue as antiquated, and may even feel surprise at our having been upon the verge of some great discoveries and yet having failed to make

them; but I venture to hope that the names of many of those living investigators which we find recorded in the Catalogue of this Exhibition may not only then, but even in after ages, be looked upon with reverence and esteem.

We must, however, turn to the consideration of the branches of science comprised under this Section, and in directing your attention to some of the objects which appear to me of more than common interest, I shall venture an occasional observation on some matters which appear to be well fitted for discussion at an international conference such as the present.

In regard to meteorological instruments we have not only isolated specimens but sets of instruments as supplied to meteorological stations, and to the royal and merchant ships of this country. With the exception of Russia, however, the means of comparison with other countries are, I believe, wanting. It will be for the representatives of other countries to see whether some useful hints may not be derived from the experience of British meteorologists as embodied in these selections of instruments.

Mr. R. H. Scott in the "Handbook to the Collection" has given so excellent an account of the nature of the meteorological instruments here exhibited that I need add but little to it, especially as he will be good enough to make a communication upon them.

Taking the principal forms it will be seen that among the barometers there are more than one exhibited which are of historical interest, while numerous examples of modern improvements in mercurial barometers are shown, of which perhaps those intended to facilitate their use and increase their accuracy when employed by travellers by land and by sea, are the most noteworthy. For ordinary use, however, that comparatively recent form of barometer, the Aneroid, seems likely to compete with the older form, and the precision of mechanism which some of them exhibit is marvellous. That extreme delicacy, however, has its disadvantages, and for trustworthy observations the actual weighing of the atmosphere by the column of mercury will long be preferred.

The principal features of the thermometers are their accuracy and sensitiveness. It might be worth while to consider whether any means could be devised for facilitating the adoption of a uniform scale of notation. It will, however, be a difficult matter to supersede the scale of Fahrenheit in this country, where it seems to have taken so deep a hold. The more general introduction of instruments marked with both Fahrenheit's and the centigrade scale might assist the adoption of the latter, but the smaller unit of heat on the former scale gives it practically some advantage.

Of anemometers, both for meteorological and mining purposes, a large number will have been seen, some of them furnished with means of recording both the direction and strength of the currents. Of several of these, details will be given at this Conference.

With respect to rain-gauges but little need be said, unless it be to call attention to the system, which, thanks to Mr. G. J. Symons, is now so universal in this country, viz., for observers who make only one daily entry of the rainfall, to take their observation at 9 A.M. and to enter the amount of rain to the preceding day. The late Meteorological Congress has no doubt discussed this and other points of international interest.

Of hygrometers, both ancient and modern forms are exhibited, the hair hygrometer still holding its own among those of the indirect class, notwithstanding the influences of modern civilisation. One cannot but be touched by the pathetic note of the Geneva Association for constructing scientific instruments. "The most isolated hamlets have now to be searched in order to obtain hair uncombed," and therefore fit for these instruments.

It is perhaps in the self-recording instruments that the greatest advance made during the last quarter of a century will be observed. The extended use of electricity and

photography has aided in this as much as in other departments of science, and the daily weather charts now issued in this country would have been impossibilities but a few years ago.

The automatic light-registering apparatus of Prof. Roscoe will it is hoped be the subject of a communication to the Conferences of this Section; but this and several other recording instruments are fully described in the Catalogue, as are also various interesting charts illustrative of meteorological influences on mortality and disease. The relation which has been found to subsist between colliery explosions and the state of the weather will form the subject of some observations to the Conference by Mr. Galloway.

There is only one other point in connection with meteorology on which I will say a few words:—that of evaporation. Two or three forms of atmometers or evaporimeters are exhibited, some of them intended to determine the quantity of water evaporated from different kinds of soil, but no form of instrument is, I believe, in the collection which will serve to ascertain the proportion of the rainfall which percolates to any given depth through a porous soil. When it is considered how large a proportion of the surface of the globe consists of such soils and how important is the question of the supply of spring-water to our wells and rivers, it will perhaps be a matter of surprise that more attention has not been directed to the subject. It is not, however, one on which to enter at length in an introductory address, though I hope to recur to it in the course of the afternoon.

The second subject comprised within our Section is that of Geography, which, thanks to our distinguished African, Asiatic, Arctic, and marine explorers is at the present time attracting so much public attention. Many of the instruments exhibited have much of historical and personal interest, among which may be reckoned the series of instruments belonging to the Ordnance Survey, some of them—like Ramsden's theodolites—exhibiting to what a point the construction of such instruments had advanced even at the end of the last century. What, however, will attract universal attention are the deep-sea sounding appliances, which have so greatly conduced to the success of the *Challenger* Expedition, and the great extension of our knowledge of the character of the deep-sea deposits of modern times, which throw so important a light on the history of many earlier geological formations.

This interest is much enhanced by the satisfaction we must all feel in again welcoming among us the distinguished naturalist who has had the scientific charge of that expedition. Let us all hope and trust that the gallant captain of the expedition during the first portion of its voyage, may in like manner return in due course with his present comrades from his still more adventurous exploration of the Arctic regions, crowned with the success which his efforts so well deserve.

Among the deep-sea sounding apparatus, that most ingenious invention of Dr. Siemens, the bathometer, which has been exhibited and described in another Section, will, no doubt, have attracted your attention, of which many of the levelling and surveying instruments exhibited in this Section are also so well worthy.

The collection of maps requires but little comment. The survey of Palestine, the charts of the Arctic Regions, the survey maps of India, and the beautifully executed maps sent from foreign countries cannot escape attention. In connection with recent explorations the remarkable section across Southern Africa, executed by Lieut. Cameron during the perilous journey from which he has just returned, will, I hope, be the subject of comment in these Conferences by its distinguished author. Nor should the ancient maps of the sources of the Nile exhibited by the Royal Geographical Society be left unnoticed. It might be a subject for discussion whether some more uniform

system of symbols for use on maps might be adopted for general use among all nations.

In the department of Geology and Mining, it may be observed that the instruments of the pure geologist are but few and comparatively simple. We have, however, before us a most valuable collection of the geological maps of various countries, showing how vast has been the advance of our knowledge in this field during the last quarter of a century. The principles on which the geological survey of this country has been directed will be illustrated by its present accomplished chief, Prof. Ramsay, and we shall, I hope, hear something as to the surveys now going on in other countries. It would be a matter well worthy of consideration in an assembly of this kind, whether for the general geological features of a country, some international system of colouring could not be agreed upon, and in future be adopted. For more detailed maps entering minutely into the subdivisions of formations, such a system might be difficult to devise, much more to carry out; but for the principal formations there ought surely to be no great difficulty. Already, for something like two centuries, the colours in heraldry have been represented all over Europe by a conventional system of vertical, horizontal, oblique, and other lines, and science would not suffer if on this occasion she walked in the wake of vanity.

Among the appliances of the geologist must be reckoned his paleontological and mineralogical collections which, however, are, except in special instances, too bulky for an exhibition of this kind. Some are, however, here, and among them, a magnificent series of rocks, minerals, and fossils from Russia, and the fossil vegetable remains, both from the Continent and England, well deserve notice. We shall, I hope, hear from Baron von Ettingshausen how the genetic descent of much of the flora of the present day may be traced back into Tertiary times, and Mr. J. S. Gardner will have something to say on the same subject.

The sub-wealden boring, which has attained a depth of 1,900 feet, without, however, reaching any rocks of Palaeozoic age, will also form a subject of comment. The process of the Diamond Rock Boring Company by which it has been carried on, has not only the advantage of being more expeditious than the older process, but has the great merit of producing such excellent cores as those which can be seen at the end of this gallery.

The ingenious machines of Mr. Sorby, illustrative of various geological phenomena, and the original drawings of Buckland and Phillips will also attract attention.

The specimens illustrative of M. Daubrée's experiments on the artificial formation of metamorphic and other rocks, and the minerals formed within the historical period by means of hot springs, will be rendered doubly attractive by the account to be given of them by that eminent geologist.

As objects of historical interest, however, the collections illustrative of the development of Davy's great invention of the safety-lamp, are perhaps unrivalled in this department. Among mining appliances and models, some few will form the subject of communications to the Conferences.

In the remaining department of this Section, that of Mineralogy and Crystallography, there is much of historical as well as scientific value. The improvements in the microscope, the polariscope, and the goniometer, have done much to advance these branches of science during the last quarter of a century, while the application of photography to the reproduction of the images observed in the microscope has most efficiently aided in bringing the results of single observers within the reach of all.

The models and diagrams illustrative of the different systems of crystallography and the various forms of crystals are remarkably excellent and complete, and some questions in connection with the properties of certain

forms of crystals, and the method of notation best adapted for international use, will probably be discussed in the Conference.

I have thus briefly touched upon some of the salient points which occur to the mind when taking a cursory view of an Exhibition such as the present. In doing so I have no doubt passed over many instruments and appliances of even greater importance than those which I have thus succinctly mentioned, and have probably left untouched many topics of the highest interest. Among the subjects, however, which will be discussed on each day of our Conferences there will, I hope, be a sufficient variety to give occasion for any one to call attention to any special features of novelty in the collection. What I have ventured to say must be regarded as merely a short introduction to communications of far greater value, from which I will no longer detain you.

SECTION—BIOLOGY

Opening Address by the President, Prof. J. Burdon Sanderson, M.D., LL.D., F.R.S.

It having been made a part of the duty of the chairman of each of the sections into which this Exhibition is divided to deliver an opening address, I had no difficulty in selecting a subject. I propose to place before you a short and very elementary account, addressed rather to those who are not specially acquainted with biology than to those who are devoted to the science, in which I shall give you a description of a few of the methods which are used in biological investigation, particularly with reference to the measurement and illustration of vital phenomena. You are aware that the Committee, in order to render these conferences as useful as possible, have thought it desirable that we should devote our attention chiefly to those subjects of which the instruments in the collection contribute the best examples.

Now these subjects are, first, the methods of registering and measuring the movements of plants and animals; secondly, the methods of investigating the eye as a physical instrument; and thirdly, the methods of preparing the tissues of plants and animals for microscopical examination. Of these several subjects it is proposed we should to-day concern ourselves chiefly with the first. I will therefore begin by endeavouring to illustrate to you some of the simplest methods of physiological measurement, particularly with reference to the time occupied in the phenomena of life, leaving the description of more complicated apparatus to Prof. Donders, who will address you on Monday, and to my friend, Prof. Marey, who is with you now, and who will give you an account of some of the beautiful instruments which he has contrived for this purpose.

The study of the life of plants and animals is in a very large measure an affair of measurement. To begin, let me observe that the scientific study of nature, as contrasted with that contemplation of natural objects which many people associate with the meaning of the word "naturalist," consists in comparing what is unknown with what is known. Whatever may be the object of our study—whether it be a country, a race, a plant, or an animal, it makes no difference in this respect, that the process in each of these cases is a process of comparison, a process in which we compare the object studied in respect of such of its features as interest us, with some known standard, and the completeness of our knowledge is to be judged of in the first place by the certainty of the standard which we use; and secondly, the accuracy of the modes of comparison which we employ. Now, when you think of it, comparison with a standard is simply another expression for measurement; and what I wish to impress is, that in biology, comparison with standards is quite as essential as it is in physics and in chemistry. Those of

you who have attended the conferences on those subjects will have seen that a very large proportion of the work of the physical investigator consists in comparison with standards. From his work, our work, however, differs in this respect, that whereas he is very much engaged in establishing his own standards and in establishing the relations between one standard and another, we accept his standards as already established, and are content to use them as our starting-point in the investigation of the phenomena which concern us.

Now I wish to illustrate this by examples. The first objects which strike the eye on entering this collection—the collection in the next room—are certainly the microscopes. But you will say, surely the microscope cannot be regarded as an instrument of measurement. In so far as it is an instrument of research and not merely a pastime, it is emphatically an instrument of measurement, and I will endeavour to illustrate this by referring to one of the commonest objects of microscopic study, namely, the blood of a mammalian animal. Now as regards the blood I will assume that everybody knows that the blood is a fluid mass, in which solid particles float. With reference to the form of those particles, all that we see under the microscope is merely a circular outline. If we wish to find out what form that represents we must use methods which are really methods of measurement. By the successive application of such methods we learn that this apparently circular form really corresponds to a disc of peculiar bi-concave shape. But I will not dwell more upon the application of measurement to the form of the corpuscles, but proceed at once to a subject that can be illustrated by an instrument before you for ascertaining the number of the corpuscles. It will be obvious to you—even to those who are not acquainted with physiology and pathology—that the question of the proportion of corpuscles which are contained in the blood must be a matter of very great importance to determine. It has been long known that the colouring matter which is contained in the corpuscles is the most important agent in the most important vital processes of the body, because it is by means of it that oxygen, which is necessary to the life of every tissue is conveyed from the respiratory organs to the tissues. This being the case, it is evidently of very great importance both to the pathologist and to the man who interests himself in investigating the processes of nature, to be able to determine accurately what proportion of corpuscles the blood contains. Well, there are chemical methods of doing this. We can do it by determining how much iron the blood contains, because we know that the proportion of iron in the corpuscles is always nearly the same, and by determining the quantity of iron chemically, we can find out how many corpuscles there are in a certain amount of blood. But this is a long process, requiring first the employment of a considerable quantity of blood, and secondly, difficult chemical manipulations and a long time. Now by a method which has been very recently introduced, we have the means of applying the microscope even to a single drop of blood, to a drop such as one could obtain by pricking one's finger at any moment, or could take, in this way, from any patient in whom it might be desirable to ascertain the condition of the blood as regards the number of its solid particles.

The method consists in this. In order that you may understand it I will ask you to fix your attention upon this cube which I draw on the board. Suppose this cube is not of the size actually represented, but that it is a cube of one millimetre, *i.e.*, the $\frac{1}{25}$ part of an inch. How many blood corpuscles do you suppose are contained in a cube of that size? Such a cube we know to contain in normal blood about 5,000,000 corpuscles. Supposing we had a method by which we could count those 5,000,000 particles it is obvious that the task would be endless, and even if we were to take a cube $\frac{1}{125}$ part of that size, namely, a

cube of one-fifth of a millimetre in measurement the enumeration would be somewhat easier, but still impossible, for the number contained in such a cube would be enormous; and therefore, it is necessary to diminish the bulk of the blood in which you make your counting very much further. This you can only effect by a process of dilution. In order to get at your result you have not only to diminish the bulk of the quantity which you contemplate and in which you count, as much as possible, but also to dilute the blood so that your liquid may contain a very much smaller proportion of blood corpuscles. You dilute it then 250 times, and in this way you divide the cube of a millimetre from which you started, into about 31,000 parts, and count the blood corpuscles in the thirty-one thousandth part of a cubic millimetre. Supposing you find it contains about 160 corpuscles you will find by calculation that they amount to about 5,000,000 in the whole cube from which you started. This being the case the question is how we effect the division. We do it in this way: You first dilute your blood in the exact proportion required, and for this purpose one uses the apparatus which is on the table. You take a capillary pipette which will only take an extremely small quantity, in fact, a cubic millimetre of blood. Then having filled your pipette you discharge it into a little eprouvette, into which has been introduced 250 times, or rather 249 times, the bulk of some liquid with which blood can be diluted without its corpuscles being destroyed. Having thus got this diluted liquid which contains blood in the proportion I have mentioned, all that you have to do is to place under the microscope a layer of a definite thickness—one-fifth of a millimetre—and count the number of corpuscles in a square of the same measurement. That is effected by this very ingenious arrangement, which was introduced by M. Potain, and has been finally perfected by Messrs. Hayem and Nacet. The way it is done is this: An object-glass is covered by a perforated plate; the perforated plate is of the thickness I mentioned, namely, exactly one-fifth of a millimetre. Consequently if a very small drop of the mixture of the blood with serum (the diluting liquid) is placed within this space, you have a layer of the thickness I have mentioned which you can contemplate. You can cut off a cubic millimetre of that stratum of blood perfectly easily by means of a micrometer eyepiece, and in that way accomplish the required enumeration. You have in short before you a quantity of liquid which contains about the thirty-one thousandth of a cubic millimetre of blood, and consequently would obtain, if the blood were normal, 160 corpuscles. These can be very readily counted, and the whole process can be done in a very few minutes—in a much shorter time, in fact, than I have taken to describe it to you, and you get results which are not only equal to those obtained by chemical investigation, but more accurate. This, I think, is a good example of the application of the microscope as an instrument of measurement to an important question.

The next subject that I wish to draw your attention to is a different one. It is a question of measuring the time occupied in certain simple processes in which the nervous system is concerned. The examples I am going to give you are entirely derived from the physiology of man, and relate to the phenomena which we observe in ourselves. The measurement to which I wish to draw your attention is the measurement of the time occupied in what we call in physiology a "reflex" process. You may reasonably ask that I should endeavour to explain what a reflex process is, and the only way, or at any rate the readiest way in which I can do this is by giving you an example. Supposing this blank card, which has written on it previously some word, say the word "reflex," were suddenly turned over by a second person. It is agreed that at the moment I see the word upon it, I say the word "reflex." In that act it is obvious that there are three

stages. First, the reception of the impression by my eye produced by seeing the word; secondly, the process which goes on in my brain in consequence of seeing it; and thirdly, a message sent out from my brain to the muscles which are concerned in articulation, by means of which certain movements are produced which give rise to the sound which you recognise as the word "reflex." That is one example. Let us now take another which is simpler. We cannot take one better than the act of sneezing. Some snuff finds its way into the nose; an impression is received, a change is produced in one's nervous centres, and in consequence of that central change, a certain number of muscles are thrown into the action recognised as sneezing. These are different examples of reflex action. The brain, the highest part of the nervous system, has to do with the first; whilst the other is one in which the nervous centres lower down have to do, and consequently it is simpler. The methods which I am going to illustrate to you are methods intended for the measurement of the time occupied in this process. First, let me draw your attention to the circumstance that you have here three stages. You have the stage of reception; the stage corresponding to the changes which take place in the brain in consequence of the reception of an impression from outside; and thirdly, the process by which you convey the effect to the muscles which act. Now let us agree, in speaking of this, to call the impression the "signal," and to call the muscular effect the "event." In that case the question before us is to measure how much time takes place between the reception of this signal by a certain person and the occurrence of the event, namely, the completion of the muscular action. There are a great many questions involved in this: thus you may measure either the whole process or one of its stages. You may measure, for example, either the time occupied by the reception, the time occupied by the discharge, or, on the other hand, the time which is occupied by the changes which take place in the centre itself. In the first instance I gave you just now—the example of reading a word aloud—the time occupied in the reception is extremely short, and the time occupied in the discharge is also extremely short. Popularly the whole thing is done as quick as thought, but, comparatively, the time the brain takes in going through these changes which connect the reception of the impression with the discharge is a very considerable one. All this we can make out with absolute accuracy by methods of measurement. Most of these methods are founded on this principle, that we measure the duration of a voltaic current which is closed at the moment the signal is given, and opened or broken at the moment that the act takes place. There are a great many instruments constructed on this principle, of which you will find illustrations in the next room. The general principle involved in all of them is shown on this diagram. In the simplest form you can give to such an apparatus you must have a surface of paper so placed that it shall pass horizontally by the point of the lever, and at a uniform rate; thus, for example, it may pass at the rate of 1 metre in the second. Supposing this to be the case, it is obvious that if you arrange the electro-magnet so that when you close the current a certain mark is made, and that at the moment of the break of the current when the magnet ceases to act, another mark is made, you will have a tracing on the surface of the paper which indicates the time. So long as nothing is going on, the paper receives a horizontal mark, but at the moment the signal is given you have the point of the lever descending. At the moment the act takes place the lever assumes its original situation, and you have again a horizontal line. That is the general principle of the apparatus. Now for its action. We have here a voltaic circuit and a key by which we can give the signal. I shall be the subject of the experiment, and you will see what the result is. Here is the recording arrange-

ment. We have two electrical keys, one at the further end intended for making what is called the signal, and one here for breaking, which is placed close to the person who is to be experimented upon. Mr. Page, at any moment he likes, will act upon me by sending an induction flash through my tongue. I shall arrange the electrodes so that they shall be against the tip of my tongue, and at the moment I feel that flash I shall place my finger on the key. Then the clockwork being in motion at the same time, we shall see by the length of the depression in the tracing the duration of the process. If we take different sorts of signals, or if the person to be experimented upon is in different conditions, the time will be very different. Thus we may compare the result which will be produced when I am attending and expecting the signal with the result which will be produced when I am not attending or expecting the signal; or, on the other hand, I may compare those results with that which will be produced when I am expecting it, but Mr. Page, instead of giving it at the time I expect it gives it me at a different time; in that case the time occupied would be longer than in either of the other two cases. A great variety of different cases can be investigated in this way in which we measure the total period occupied in the reflex. The arrangement is perfectly simple. You see when Mr. Page presses on his key, which is the signal key, that a lever is set in vibration and makes a tracing, and at the same moment the voltaic current is made and the coil is acted upon inductively; the result is that an induction flash passes through my tongue which I feel, and the moment I feel it I break the current. Consequently the time between the moment at which Mr. Page makes the current by closing his key and the moment at which I break the current by placing my finger on my key, gives us precisely the time which is occupied by the reflex process. We will make two experiments, first, with the signal expected, and then unexpected; that is, in the one case I shall be on the *qui vive*, and on the other I shall not be so. (The experiments were made accordingly.) We shall now repeat the process, so that instead of my receiving the information of the making of the current by means of the excitation of my tongue, the signal shall consist in my hearing the sound of an electrical bell. In that case we shall find that, although the signal will come in exactly the same way, practically the time occupied will be very considerably longer, showing that a signal received by sound takes longer in producing its effect than one in which the signal is felt by the tongue.

In order to make all this perfectly plain I shall hand round this tracing. You will see there several experiments made with expected and unexpected signals, which show the different results obtained in the two cases.

The next question which arises, and with that I must conclude what I have to say just now, is this:—You will readily see that the exact measurement of time depends upon the rate at which this clockwork happens to be going. I happen to know that it makes twenty revolutions per second. But suppose I do not know that. In fact one would not trust to the accuracy of clockwork for such a purpose. How should I then be able to measure the duration of time so exceedingly short as the one which now concerns us? In order to do this we always come back to a physical standard, to a standard of absolute invariability which we can depend upon as being true. For this purpose we use a tuning-fork which produces vibrations, the rate of which we know, because we know the tone which the tuning-fork produces, and the arrangement which is always used for this purpose is the one shown here. We have turned off the voltaic current we used for signalling, and turned it on the tuning-fork. There are two electro-magnets on either side of the tuning-fork which react upon it, so that the moment you close the current the fork is thrown into vibration and

produces its own characteristic note. All that we have to do is, during the time we are making our record, to bring this tuning-fork, which is now in vibration, into such a position that this little brass pointer shall make a tracing against the paper. If you look at the tracing I have sent round you will find there are tracings on it of a fork, which vibrates at the rate of 100 per second, consequently you have nothing to do but to translate the tracings which you have made and which correspond to the duration of the mental process which you have been investigating, into vibrations of the tuning-fork, and you get an exact measurement of the total duration of the process. While I have been doing this you hear the tuning-fork is in vibration, and Mr. Page has made the tracings. After it is varnished it will be sent round and you will see the tracing made by the fork over the traces corresponding to the different experiments we made just now.

I may observe that although the experiments made on that paper were made with myself, you find that the period occupied by the reflex is considerably longer than in the other which I sent round previously. But that one may very easily explain from the abnormal conditions under which the experiment has been made as regards myself.

I intended to go on from this subject to another mode of investigation, namely, to the very beautiful instruments which have been lately introduced for the purpose of measuring the finest differences of bulk in different organs, as for example, in the human arm, by which you can ascertain the condition of the circulation precisely by a very exact registering-measurement of the bulk of the arm;¹ but as there are several other gentlemen now ready to address you, I will defer that till this afternoon. I will now conclude what I have to say by asking you to listen to Dr. Hooker.

SCIENCE IN GERMANY

(From a German Correspondent.)

HERR v. OBERMAYER has recently communicated a memoir to the Vienna Academy on the relation of the coefficient of internal friction of gases to the temperature. If we accept for the coefficients of friction μ at $t^\circ \text{C.}$, the formula—

$$\mu = \mu_0 (1 + at)^n$$

where a is the coefficient of expansion of the gas, taken as basis of the calculation, then the experiments of Obermayer give the following results:—

For Air ...	...	...	$n = 0.76$
„ Hydrogen ...	...	...	$n = 0.70$
„ Oxygen ...	...	...	$n = 0.80$
„ Carbonic oxide ...	...	...	$n = 0.74$
„ Ethylene ...	...	...	$n = 0.96$
„ Nitrogen ...	...	...	$n = 0.74$
„ Protoxide of nitrogen ...	...	...	$n = 0.93$
„ Carbonic acid ...	...	...	$n = 0.94$
„ Ethyl chloride ...	...	...	$n = 0.98$

The coefficient of friction of the permanent gases is, according to these experiments, approximately proportional to the $\frac{2}{3}$ -power of that of the coercible gases, and to the 1-power of the absolute temperature.

For temperatures between 150° and 300°C. , air gave the same values of n as between the lower temperatures $-21^\circ 5$ and $53^\circ 5$. In the case of carbonic acid a slow decrease of the exponent n with the temperature was perceptible from the experiments. W.

NOTES

ON Tuesday a visit was paid to the *Challenger* at Sheerness by several Fellows of the Royal Society, foreign men of Science, who are in London in connection with the Loan Collection

¹ The apparatus was fully described subsequently by Mr. Gaskell.

Conferences, and representatives of the Science and Art Department. Among those who made up the party were Lord Clarence Paget, Sir Henry Cole, Mr. Norman Macleod, Majors Donnelly and Festing, Mr. E. J. Reed, M.P., Professors Allman and Crum-Brown, Mr. Norman Lockyer, Professor Eccher, Baron von Wrangell, Dr. Biedermann, and others. Luncheon was served in the Ward-room, but as there was not sufficient accommodation for all the visitors many left by special train for Chatham, where luncheon had been provided in the Engineers' Mess-room. Invitations to visit the *Challenger* have been sent by the Admiralty to all the English and foreign members the Kensington Loan Apparatus Committee, many of whom have accepted them. The *Challenger* will be open to inspection to-morrow. The ship lies at present in the very spot she left when she set out on her cruise three and a half years ago, and to-day she is to be swung for the adjustment of her compasses and the taking of magnetic observations. It is thought that ten or twelve days will elapse before all the stores can be taken out to enable her to pay off.

FROM the official list of visitors to the Loan Collection during last week, which we give below, it will be seen that full advantage is being taken of the opportunity afforded:—

Monday	...	...	...	1,822
Tuesday	...	...	...	2,816
Wednesday	...	...	...	772
Thursday	...	...	...	891
Friday	...	...	...	939
Saturday	...	...	...	3,457
Total	...	...	...	10,697

DR. DONDERS, of Utrecht, and Prof. van Beneden, of Louvain, are two of the latest arrivals in connection with the Loan Collection Conferences.

IT is proposed to hold an International Convention of Archaeologists, at Philadelphia during the Centennial, and in connection with the Centennial Exposition, for the purpose of promoting acquaintance and increasing the means of information in American Archaeology and Ethnology. The State Archaeological Society of Ohio will provide rooms for the Convention, and the first meeting will be held in the Ohio Building, at 2 o'clock, P.M., Sept. 4, 1876. The American Association for the Advancement of Science, meets at Buffalo, N. Y., Aug. 23, at which time a Subsection of Anthropology will be formed. The Convention has been appointed near the close of the session of the Association in order that those who desire may conveniently attend both meetings. Large collections, in Ethnology and Archaeology, from the Smithsonian Institution, the State Society of Ohio, and other public and private sources will be on exhibition, and will furnish a great incentive for Archaeologists to visit the Exposition. The meeting of this Convention at Philadelphia, must be regarded on that account as very opportune, and a large attendance is expected. Addresses from prominent anthropologists will be delivered, and it is hoped that a great impetus to investigations in America will be gained. Archaeologists who purpose to attend are requested to bring any articles or illustrations which they may have, as the opportunity for a temporary exhibition will be given. The Chairman of the Ohio Committee is the Rev. S. D. Peet, of Ashtabula, O. European men of science who intend to be present at the Buffalo meeting of the American Association, should write to Prof. F. W. Putnam, Salem, Mass., who might be able to make arrangements, by which their expenses would be kept down.

IN connection with the great International Exhibition at Philadelphia, it is interesting to note that that city is one of the healthiest in the world, so far as the death-rate is a test. In

1874, according to an official circular just issued, with a population of 775,000, the death-rate was only 19·3 per thousand. This very favourable result is largely due to the abundant and cheap water-supply, and to the opportunities given, even to the poorest citizens, for the enjoyment of pure country air in the great Fairmount Park, which contains 2,991 acres. The most powerful influence of all, however, is the absence of that overcrowding of the population, which is the most fruitful source of sickness and death in many quarters of nearly all other large cities. This will be more clearly comprehended when it is remembered that the 817,488 inhabitants of Philadelphia are spread over an area of 129½ square miles, which are traversed by more than one thousand miles of streets and roads. The climate of Philadelphia is also, on the whole, a favourable one, although presenting many of the peculiarities common to inland localities. The mean annual temperature of the last ten years is 53·73° Fahrenheit; the average annual rain-fall is about forty-five inches.

THE Conversazione of the President of the Institution of Civil Engineers takes place to-night in the South Kensington Museum itself, instead of in the Galleries devoted to the Scientific Apparatus Exhibition, as was at first intimated.

WE are informed that the new Zoological Gardens of Calcutta will be opened on the 6th of this month, and that Mr. J. C. Parker has been appointed temporary Curator of the establishment. There is a fine show of Indian Ruminants and other ordinary Indian animals; a splendid pair of the Himalayan Bears (*Ursus tibetanus*), and likewise examples of the other Indian species, *Ursus labialis*, *U. malayanus*, and *U. isabellinus*. Among the rarities is a cage full of the Indian Tupaia (*Tupaia ellioti*), a curious insectivorous form, of which the Zoological Society of London had living examples not long since.

THE *Pandora* left Portsmouth on Saturday on her voyage to the Arctic Regions. One of her main objects is to take out letters, papers, &c., for the officers and crews of the *Alert* and *Discovery*; these will be deposited in certain dépôts on the chance of Capt. Nares being able to communicate with the entrance to Smith's Sound. The *Pandora* takes out a very considerable number of letters and packets of various kinds, and not the least interesting news to Capt. Nares will be that of the successful conclusion of the *Challenger* Expedition. It is generally understood that, after depositing his mail, Capt. Young will make another attempt to push his ship through Peel Straits, or Bellot Straits, and Franklin Channel, and so on into Behring Straits, and thus be the first to make the North-west Passage by sea.

It is encouraging to find our legislators and "leaders of industry" enlightened enough to realise and plainly state the condition of this country with regard to scientific education. The place which this country at present holds in the matter of scientific industry, as contrasted with Continental countries and with America, has been frequently referred to of late both by public men and in these columns. The case was again briefly but pointedly stated by Mr. Samuel Morley, M.P., on Monday, at the Annual Meeting of the Artisans' Institute. "It was," he said, "essential that our sons of toil should become humble disciples of science if England was to keep pace with foreign nations in the excellence of her manufactures. The competition of industry was rapidly becoming a competition of intellect; and Belgium, Germany, and America were fast treading upon our heels in the quality of their manufactures. Seeing that at no period for thirty years had there been so widespread a depression in trade as at present, he thought the great importance of imparting scientific instruction, with a view to the maintenance of our position, would be sufficiently obvious to all. Unless this was brought to bear upon our manufactures, the situation of this

country would be one of great peril, and he sincerely hoped that the advantages offered to the working classes would be thoroughly appreciated by those whom the organisation was intended to benefit." We hope that sentiments like these will have due weight in the framing of our Education Codes.

We are glad to hear that the Duke of Cleveland has directed the Shropshire meteorite to be placed at the disposal of the authorities of the British Museum.

In October next, we learn from the *Western Daily Press*, the Bristol University College will be an accomplished fact. Professors of Chemistry and of Modern History, and Literature are to be appointed for the opening of the first session and Lectures delivered on the following subjects:—Mathematics and Applied Mechanics, Experimental Physics, Political Economy, and Classical History and Literature. It is gratifying to find that public spirit in Bristol has not only not allowed a great opportunity to pass, but has brought the College into existence, as a working institution, with praiseworthy rapidity. The council has appointed Mr. F. N. Budd as chairman, Mr. W. Proctor Baker as treasurer, and Mr. Edward Stock, secretary.

B. C. DUMORTIER'S "Hepaticæ Europeæ," published by C. Muquardt of Brussels, is the only work which gives a complete account of the Hepaticæ or Liverworts of Europe, and embraces the work of more than fifty years of a veteran botanist. For a limited period, until July 1, the work is offered at a reduced price of 5fr., after which the published price will be 8fr. It is illustrated with four coloured plates.

By authority of M. Waddington, the older pupils of the National School of Agriculture, established at Grignon, in France, left, on May 25, for the Netherlands, where, with their professors, they are to make an agricultural tour which is to last for three months. It is stated that they will come to England next year. Grignon was the first agricultural school established in France, and was purchased by the Government many years ago. The course of studies is for three years.

DR. LELORRAIN, a *licencié* in natural science, has just organised a series of scientific excursions in the vicinity of Paris. They are to take place each Sunday during the months of June, July, and August. The excursionists will receive practical instruction in geology, botany, and entomology, by competent teachers.

ON Monday June 26, an extraordinary session of the French Botanical Society will be held at Lyons. A number of botanists from Belgium and Switzerland will join the Society, and an important botanical exploration will be made. English botanists will be very heartily received. Particulars may be obtained by directing letters to the General Secretary, 84, rue de Grenelle, St. Germain, Paris.

THE eighth session of the International Anthropological and Archaeological Society will be held at Buda-Pesth, under the presidency of M. Francois Pulszky, General Inspector of the Public Libraries in Hungary. The General Secretary of the Buda-Pesth Congress is M. Florian Romer. An English committee will be appointed.

WE are glad to see that a second edition of Mr. W. N. Hartley's "Air and its Relations to Life," has been published by Messrs. Longman and Co. In this edition Prof. Tyndall's recent experiments are described.

WE have received Dr. C. Bruhn's monthly reports of the meteorological observations made at twenty-four stations in Saxony during 1875. To the reports which briefly summarise the results for each month is appended an interesting *résumé*,

pointing attention to the more striking features of the weather during the year, and comparing these with the results of previous years' observations, and giving the annual means and extremes of all the meteorological elements at each station, together with the dates of occurrence of several interesting phenomena, such as the day of heaviest rainfall, of greatest dryness of the air, and the latest and earliest frost and snow.

In the *Bulletin International* of the Paris Observatory of May 17 to 19, there appears an important paper by M. Belgrand, on the means of protecting Paris from the inundations of the Seine. The great flood of March 17 last marked 107½ feet on the river-gauge at the bridge of Tournelle, which is three feet less than the height to which the great flood of Jan. 3, 1802, rose, and 7½ feet less than that of Feb. 27, 1658, the greatest flood on record. With a view of protecting the parts of the city liable to suffer from such floods, M. Belgrand proposes to prolong the main drains and the embankments down the river as far as the fortifications, to isolate them completely from the river, and to keep them, by means of machinery, at their normal level. Further, to prevent the flooding of cellars, he proposes a system of drainage at a lower level than that of the cellars liable to be flooded, and having no communication with the river and the main drains, these drains to be kept at the proper level by centrifugal pumps and turbines driven by the water of the city.

WE have received the first part of the first vol. of a "Handbuch der Palæontologie," by Profs. Schimper and Zittel. It is published at Munich, by R. Oldenbourg.

MR. W. DITTMAR has just published (Edmonston and Douglas) a collection of useful Tables as an Appendix to his "Manual of Qualitative Chemical Analysis," which we recently noticed.

"ESSAY on the Use of the Spleen, with an Episode of the Spleen's Marriage, a Physiological Love-story," is the title of rather an original little work just published by Dr. Patrick Black (Smith, Elder, and Co.).

AS Supplement 47 to Petermann's *Mittheilungen*, has been published an account of Herr G. A. Hagenmacher's Travels in Somali Land. The author gives a systematic account of his observations in this region of Africa, under the headings of Narrative of the Journey, Physical Geography, Ethnography and Ethnology, Agriculture and Cattle-breeding, Industries and Trade, and a History of the Somalis.

THE latest additions to the Royal Westminster Aquarium include the following:—Hawksbill Turtles (*Caretta imbricata*), from the West Indies; Picked Dogfish (*Acanthias vulgaris*), and Lesser Spotted Dogfish (*Scyllium canicula*), presented by the Yarmouth Aquarium Society; Armed Bullheads (*Agonus cataphractus*), Greater Pipefish (*Syngnathus acus*), Sea Horses (*Hippocampus ramulosus* et *brevivestris*), Venus's Ear-shells (*Elaiotis tuberculata*), from Guernsey; Sea Mice (*Aphrodite aculeata*), Purple Urchins (*Echinus lividus*), Sun Starfish (*Solaster papposa*), Mediterranean Corals (*Balanophyllia verrucaria*), Venus's Flower-basket Sponge (*Euplectella aspergillum*), from the island of Zebu, Collected and presented by Capt. W. Chimmoo, R.N.

THE additions to the Zoological Society's Gardens during the past week include a Silver Pheasant (*Euplocamus nychthemerus*) from China, presented by Mr. W. Miles; a Common Barn Owl (*Strix flammea*), European, presented by Mrs. Knight; a Blue-faced Amazon (*Chrysotis amazonica*) from South America, presented by Miss M. Jukes; a Silky Marmoset (*Midas rosalia*), a Huanaco (*Lama huanaco*), an Azaras Fox (*Canis azaras*), three Chinchillas (*Chinchilla lanigera*) from South America, deposited.

SCIENTIFIC SERIALS

THE *Journal of Mental Science*, April, 1876.—Reflex, automatic, and unconscious cerebration, a history and a criticism, by Thomas Laycock, M.D., is continued and completed in this number. The paper is very interesting. Dr. Laycock takes great pains, and is, we think, successful in making good his claim to priority over Dr. Carpenter in certain views of an advanced nature, which, if they are not already, will soon be entirely absorbed in others much more advanced.—Dr. John M. Diarmid writes in high praise of morphia in the treatment of insanity, when administered subcutaneously.—Dr. Daniel Huck Tuke gives an historical sketch of the past asylum movement in the United States, doing full justice to the enlightenment and humanity of American physicians, while recording the outstanding difference between them and their English brethren in the principle and practice of non-restraint.—A modest but suggestive paper on the use of analogy in the study and treatment of mental disease, is contributed by Dr. J. R. Gasquet.—Dr. P. Maury Deas describes a visit to the Insane Colony at Gheel, where the accumulating experience of a thousand years has produced an instinctive aptitude to manage the insane worth more in practice than the best of our consciously-formed systems.—Dr. Isaac makes some interesting observations on general paralysis.—“Arthur Schopenhauer: his Life and his Philosophy,” by Helen Zimmern, is reviewed in a manner worthy the book and its subject.—The *Journal* contains other reviews, clinical notes and cases, news, &c.

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, Feb. 1.—In this number appears the first part of a paper by Dr. W. Köppen, on the yearly periods of probability of rain in the northern hemisphere. It is accompanied by a valuable diagram of curves. He begins by calling attention to the value of the system on which his calculations are based, namely, the mere registration of the days of which rain falls in each locality. Considering that in our latitudes changes of vapour tension and of relative humidity do not concur, it is simpler than measuring the quantity of rain or snow. The probability of a downfall depends upon two conditions, the degree of relative humidity between, say 100 and 3,000 metres altitude, and the favourable or unfavourable circumstances for the formation of an ascending current, or, firstly, on the rate of decrease of temperature with height; secondly, on the slope of the ground towards the direction of the wind, while the quantity depends also on the quantity of vapour contained in a volume of air, and so, *ceteris paribus*, on the temperature. He then gives a detailed account of the authorities from whom he has derived his materials. The selected stations are well distributed over the greater part of the northern hemisphere, including the North Atlantic, and have most of them afforded records during more than ten years. As in his former writings on the subject, he represents graphically the means of groups of neighbouring stations having similar annual distribution of rainfall, but annexes a table showing the actual numbers for each station. The diagram exhibits the probability of rain in each month for each district.

Feb. 15.—In this number Dr. Köppen concludes his remarks on the yearly periods of probability of rain. The paper, which is illustrated by elaborate tables, contains much valuable information respecting the times of year at which rain is most and least probable in a great number of countries and districts of the northern hemisphere.

Gazzetta Chimica Italiana, Anno VI., 1876, Fascicolo 1.—Synthesis of the sulpho-tannic acids, by Hugo Schiff. The author in this paper treats of phenol-sulphuric anhydride, trichlorhydroquinone-sulphuric acid, sulphopyrogallie acid, sulphotannic and pentacetosulphotannic acids, the sulpho-acids of phoroglucin, &c.—On the elasticity of metals at different temperatures, by G. Pisati. In this paper the author investigates the elasticity of iron and steel, arriving at the following formula:—

$$K = \frac{P \cdot L_0 (1 + \alpha t)}{\pi r_0^2 (\frac{1}{2} + \alpha t)^2 \cdot l} = \frac{P \cdot L_0}{\pi r_0^2 \cdot l} \cdot \frac{1}{1 + \alpha t}$$

where K is the modulus of elasticity of stretching force, P the weight which acting on the length of wire L_0 , produces the lengthening l , α is the co-efficient of linear expansion.—Modification of the process for the extraction of alkaloids in poisoning of the viscera, by F. Selmi.—On a method of detecting traces of phosphoric acid in toxicological researches, by F. Selmi.—On the use of phylloxyaniline as a reagent, by Guido Pellagri.—Action of iodide of allyl and zinc on oxalic ether, by E. Paterno

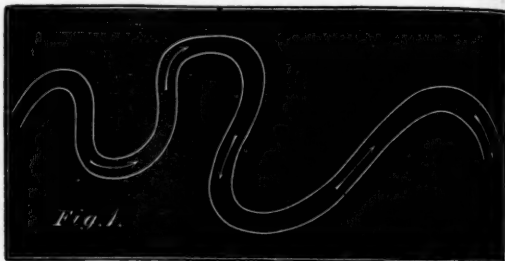
and P. Spica.—Chemical researches upon twelve coloured solids found at Pompeii.—The remainder of the part is occupied by extracts from foreign journals.

SOCIETIES AND ACADEMIES

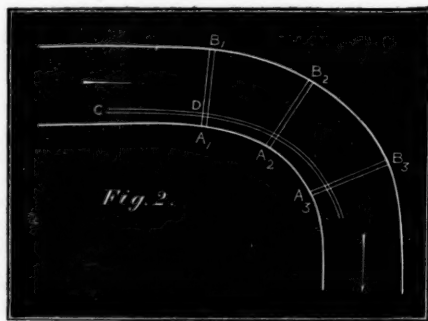
LONDON

Royal Society, May 4.—“On the Origin of Windings of Rivers in Alluvial Plains, with Remarks on the Flow of Water round Bends in Pipes,” by Prof. James Thomson, LL.D., F.R.S.E. Communicated by Prof. Sir William Thomson, F.R.S.

In respect to the origin of the windings of rivers flowing through alluvial plains, people have usually taken the rough notion that when there is a bend in any way commenced, the water just rushes out against the outer bank of the river at the bend, and so washes that bank away, and allows deposition to



occur on the inner bank, and thus makes the sinuosity increase. But in this they overlook the hydraulic principle, not generally known, that a stream flowing along a straight channel and thence into a curve, must flow with a diminished velocity along the outer bank, and an increased velocity along the inner bank, if we regard the flow as that of a perfect fluid. In view of this principle, the question arose to me some years ago, *Why does not the inner bank wear away more than the outer one?* We know by general experience and observation that in fact the outer one does wear away, and that deposits are often made along the inner one. *How does this arise?*



The explanation occurred to me in the year 1872, mainly as follows:—For any lines of particles taken across the stream at different places, as A_1B_1 , A_2B_2 , &c., in Fig. 2, and which may be designated in general as AB , if the line be level, the water pressure must be increasing from A to B , on account of the centrifugal force of the particles composing that line or bar of water; or, what comes to the same thing, the water-surface of the river will have a transverse inclination rising from A to B . The water in any stream line CDE at or near the surface, or in any case not close to the bottom, and flowing nearly along the inner bank, will not accelerate itself in entering on the bend, except in con-

¹ This, although here conveniently spoken of as a stream-line, is not to be supposed as having really a steady flow. It may be conceived of as an average stream-line in a place where the flow is disturbed with eddies or by the surrounding water commingling with it.

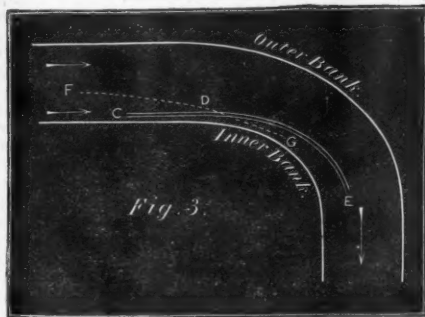
sequence of its having a *fall of free-level* in passing along that stream-line.¹

But the layer of water along the bottom, being by friction much retarded, has much less centrifugal force in any bar of its particles extending across the river; and consequently it will flow sidewise along the bottom towards the inner bank, and will, part of it at least, rise up between the stream-line and the inner bank, and will protect the bank from the rapid scour of that stream-line and of other adjacent parts of the rapidly flowing current; and as the sand and mud in motion at bottom are carried in that bottom layer, they will be in some degree brought in to that inner bank, and may have a tendency to be deposited there.

On the other hand, along the outer bank there will be a general tendency to descent of surface-water which will have a high velocity, not having been much impeded by friction; and this will wear away the bank and carry the worn substance in a great degree down to the bottom, where, as explained before, there will be a general prevailing tendency towards the inner bank.

Now further, it seems that even from the very beginning of the curve forward there will thus be a considerable protection to the inner bank. Because a surface stream-line C D, or one not close to the bottom, flowing along the bank which in the bend becomes the inner bank, will tend to depart from the inner bank at D, the commencement of the bend, and to go forward along D E, or by some such course, leaving the space G between it and the bank to be supplied by slower moving water which has been moving along the bottom of the river perhaps by some such oblique path as the dotted line F G.

It is further to be observed that ordinarily or very frequently there will be detritus travelling down stream along the bottom



and seeking for resting places, because the cases here specially under consideration are only such as occur in alluvial plains; and in regions of that kind there is ordinarily² on the average more deposition than erosion. This consideration explains that we need not have to seek for the material for deposition on the inner bank in the material worn away from the outer bank of the same bend of the river. The material worn from the outer bank may have to travel a long distance down stream before finding an inner bank of a bend on which to deposit itself. And now it seems very clear that in the gravel, sand, and mud carried down stream along the bottom of the river to the place where the bend commences, there is an ample supply of detritus for deposition on the inner bank of the river even at the earliest points in the curve which will offer any resting place. It is especially worthy of notice that the oblique flow along the bottom towards the inner bank begins even up stream from the bend, as already explained, and as shown by the dotted line F G in Fig. 3. The transverse movement comprised in this oblique flow is instigated by the abatement of pressure, or lowering of

free-level, in the water along the inner bank produced by centrifugal force in the way already explained.

It may now be remarked that the considerations which have in the present paper been adduced in respect to the mode of flow of water round a bend of a river, by bringing under notice, conjointly, the lowering of free-level of the water at and near the inner bank, and the raising of free-level of the water at and near the outer bank relatively to the free-level of the water at middle of the stream, and the effect of retardation of velocity in the layer flowing along the bed of the channel in diminishing the centrifugal force in the layer retarded, and so causing that retarded water, and also frictionally retarded water, even in a straight channel of approach to the bend, to flow obliquely towards the inner bank, tends very materially to elucidate the subject of the mode of flow of water round bends in pipes, and the manner in which bends cause augmentation of frictional resistance in pipes, a subject in regard to which I believe no good exposition has hitherto been published in any printed books or papers; but about which various views, mostly crude and misleading, have been published from time to time, and are now often repeated, but which, almost entirely, ought to be at once rejected.

Mathematical Society, May 11.—Prof. H. J. S. Smith, F.R.S., president, in the chair.—Dr. Logan was elected a member of the Society.—Mr. Tucker communicated a paper by Mr. S. A. Renshaw, on the inscription of a polygon in a conic section, subject to the condition that each of its sides shall pass through a given point by the aid of the generating circle of the conic. The inscription of a polygon in a circle, subject to the like condition, has been accomplished by several eminent geometers, in a remarkably easy manner by the late Mr. Swale. The object of Mr. Renshaw's paper is to show how, by an easy transformation, effected by means of the generating circle, the construction of the problem in the circle can be rendered available to the resolution of the same problem in the conic sections. The author draws figures exhibiting the inscription of a pentagon in an ellipse, and of a quadrilateral in a hyperbola. Mr. Renshaw also extends some other properties (for the circle) given by Mr. Swale in the *Liverpool Apollonius* (p. 45) to the conic sections.—Prof. Cayley then spoke on the representation of imaginary quantities by an (n, n) correspondence. The Chairman and Dr. Hirst spoke on the subject of this paper. Prof. Cayley having taken the chair, the President communicated two notes. The first was on a theorem relating to the Pellian equation. Let D be any integral number, let T and U be the least integral numbers which satisfy the Pellian equation $T^2 - DU^2 = 1$; and let $\Omega_1, \Omega_2, \Omega_3, \dots, \Omega_{2n}$ be the period of complete quotients of the form $\sqrt{D + \frac{C}{P}}$ which is obtained in the development of

the root of any quadratic equation of determinant D in a continued fraction. The equality

$$\Omega_1 \times \Omega_2 \times \dots \times \Omega_{2n} = T + U\sqrt{D}$$

was established in the note, and an expression for the number of non-equivalent quadratic forms of determinant D was deduced from it. The second note was on the value of a certain arithmetical determinant. Let (m, n) represent the greatest common divisor of m and n ; and let $\psi(m)$ represent the number of numbers prime to m , and not surpassing m ; the equality

$$\sum \pm (1, 1) (2, 2) \dots (m, m) = \psi(1)\psi(2) \dots \psi(m)$$

was established in the note, and several consequences deduced from it.

Zoological Society, May 16.—Dr. A. Günther, F.R.S., vice-president, in the chair.—Dr. P. Comrie exhibited and made remarks on the zoological specimens collected by him during the survey of the south-eastern coast of New Guinea by H.M.S. *Basilisk*.—Dr. Günther exhibited and made remarks on a collection of Mammals from the coast of Borneo, opposite to Labuan. Among these were especially noticed a young example of a Monkey (*Macacus melanotis*) of which the exact habitat was previously unknown, and a new species of *Tupaia*, proposed to be called *T. minor*.—Dr. Günther also read an extract from a letter recently received from Commander Cookson, R.N., stating that he was bringing home from the Galapagos Islands a living pair of the large Land-tortoise, of Albemarle Island. Commander Cookson stated that the male of this pair weighed 270 lbs., the female 117 lbs.—Mr. Sclater exhibited the skin of a rare Pacific Parrot (*Coriphilus kukli*), which had been obtained by Dr. T. Hale Streets, U.S. Navy, at Washington Island, of the Palmyra group, and had been sent to him for examination

¹ It must be here explained that, by the *free-level* for any particle, it is to be understood the level of an atmospheric end of a column, or of any bar, straight or curved, of particles of statical water, having one end situated at the level of the particle, and having at that end the same pressure as the particle has, and having the other end, consisting of a level surface of water, freely exposed to the atmosphere, or else having otherwise atmospheric pressure there; or briefly we may say that the *free-level* for any particle of water is the level of the atmospheric end of its pressure column, or of an equivalent ideal pressure-column.

² That is to say, except when by geological changes the causes which have been producing the alluvial plane have become extinct, and erosion by the river has come to predominate over deposition.

by Dr. E. Coues.—Prof. Martin Duncan, F.R.S., read the second portion of a memoir on the *Madreporaria* dredged up during the expedition of H.M.S. *Porcupine*.—Prof. Duncan also read descriptions of new littoral and deep-sea corals from the Atlantic Ocean, the Antilles, the New Zealand and Japanese Seas, and the Persian Gulf.—Prof. W. H. Flower, F.R.S., read a paper on some cranial and dental characters of the existing species of *Rhinoceroses*. This paper contained the result of the examination of fifty-three skulls of *Rhinoceroses* contained in the Museum of the College of Surgeons and the British Museum, and described the principal characteristics of the five forms under which they could all be arranged, viz.: 1. *Rhinoceros unicornis*, Linn. (including *R. stenocephalus*, Gray); 2. *Rhinoceros sondaicus*, Cuv. (including *R. floweri* and *R. nasalis* of Gray); 3. *Ceratohinus sumatrensis*, Cuv. (including *C. niger* Gray); 4. *Atelodus bicornis*, Linn. (including *A. keiltoni*, A. Smith; 5. *Atelodus simus*, Burchell. It was also shown that the skull of a *Rhinoceros* lately received at the British Museum from Borneo, was that of a two-horned species not distinguishable from *C. sumatrensis*.—A communication was read from Dr. Julius von Haast, F.R.S., containing some further notes on *Odolodon grayi*, a new genus of Ziphioid Whales, from the New Zealand Seas.

GENEVA

Physical and Natural History Society, February 3.—Prof. Marignac gave a *résumé* of researches on the specific heats of saline solutions. This work, the result of a long series of experiments, does not lead to any general law enabling us to infer the specific heat of the solution from that of the constituent elements, bases, or acids. This paper is published in the *Archives des Sciences*.—M. Théod. Turrettini, who has to make frequent visits to the boring of the St. Gothard tunnel, gave an account of a phenomenon which is frequently produced during the progress of the work in the granitic mass of the mountain. When the rock is shaken by the explosion of a mine, the reports resulting from the explosion are not the only immediate ones produced. Afterwards, and at unequal intervals, other spontaneous explosions are produced, at considerable distances from the mine-hole, of which the cause is unknown, and which cause numerous accidents to the workmen. The phenomenon is new, and it appears to indicate in the very substance of the granite, a species of tension inherent in its formation, and which, agitated at one point, is transmitted to a distance so as suddenly to disengage large fragments of material. It may be compared with the experiment daily made by the quarrymen who work the erratic blocks in the valleys of the Alps, to obtain building materials. In order to obtain them they use wedges of wood which they drive into holes pierced for the purpose, and which, being wetted, cause by their expansion the disjunction of the granitic masses. This disjunction is not produced by gradual fissures as in the case of mill-stones, for example. It is always accompanied by an explosion more or less violent, and the two disjoined surfaces cannot again be exactly fitted to each other. There is deformation of the material, leading to the presumption of a state of latent tension existing in the constitution of the rock itself, and which a point hitherto quite mysterious, may throw light on the mode of formation of these ancient rocks.

PARIS

Academy of Sciences, May 22.—Vice-Admiral Paris in the chair.—The following papers were read:—Second note on theoretical and experimental determinations of the ratio of the two specific heats in perfect gases whose molecules are monatomic, by M. Yvon Villarceau.—M. Vulpian was elected Member in the Section of Medicine and Surgery, in room of the late M. Andral.—On photographic images obtained at the foci of astronomical telescopes, by M. Angot. The dimension of the image increases considerably with duration of exposure and intensity of the light. The phenomenon is the same, whether the collodion be dry or moist; also when the intensity of light is varied, the time of exposure remaining constant. M. Angot was led to reject the idea of a travelling (*cheminement*) of the photographic action. He deduces the effects from the ordinary theory of diffraction.—Action of organic acids on the tungstates of soda and potash, by M. Lefort.—On the physical properties of water supply, by M. Gerardin. He distinguishes two types—blue water and green water—represented at Paris by the Vanne and the Seine respectively. The blue is changed into green in many ways, but most powerfully by organic matter in decomposition.—On the lead contained in certain platinum points used in lightning-

conductors, by M. de Luca. Two such points were fused by lightning at the Vesuvius Observatory in March; they contained 10 to 12 per cent. of lead. Platinum points for lightning rods should have at least a density = 21.—On the antiseptic properties of borax, by M. Larrey.—On the preparation of a mixture containing cyanide of potassium, for destruction of phylloxera, by M. Milius.—On instrumental diffraction, by M. André. He draws some inferences from the fact that two observers with telescopes of different apertures do not perceive the moon's limb at the same instant; the telescope with the smaller aperture will show it a little sooner than the other.—Modifications in electric piles, rendering their construction easier and more economical, by M. Onimus. He substitutes parchment paper for the porous vessel. Thus a simple and good sulphate of copper pile may be made by wrapping a zinc cylinder in parchment paper, winding spirally a copper wire round this and immersing the whole in a sulphate of copper solution.—New experiments on the flexibility of ice, by M. Bianconi. Ice expelled by constant pressure (by an iron plate *e.g.*) rises in a crest about the compressing body. It has, manifestly, compressibility or plasticity, but slow and very limited.—On nitrides and carbides of niobium and tantalum, by M. Joley.—Normal pyrotartaric acid, by M. Reboul.—On electrolysis of derivatives of aniline, phenol, naphthylamine, and arthraquinone, by M. Goppelsroeder.—On the fixation of atmospheric nitrogen by mould, by M. Schloesing. M. Deherain's experiments to prove that gaseous nitrogen can be fixed in a state of combination by various organic matters, were repeated (with certain precautions) by the author, but with negative results.—On the nature of the mineral substances assimilated by champignon, by M. Cailliet. The mycelium takes from the soil almost the whole of the alkalies and phosphoric acid present. The ashes of champignons are simpler than those of chlorophyll plants. Silicon and iron, important elements in the latter, are absent in the former; which are also poor in lime and magnesia. The author explains how fairy circles are formed.—On the anatomy of the musical apparatus of the grasshopper, by M. Carlet. He corrects, in some points, what has hitherto been taught about this organ.—On a new species of psorospermia (*Lythocystis Schneideri*) parasite of *Echinocardium cordatum*, by M. Giord.—On the deposits of quaternary fossils in Mayenne, by M. Gaudry. This district, which has not yet attracted much of the attention of geologists, is one of the most interesting in France for study of quaternary palæontology.—The Akkas, or dwarfs, of the interior of Africa, by M. Mariette. Dwarfs play an important part in the religions of the ancient Egyptians, and it is probable the latter knew the country of the Niams-Niams.—Traumatic tetanus treated successfully by intravenous injections of chloral, note by M. Oré.—On the erosions which must be attributed to action of diluvial waters, by M. Robert. There are, on hill-sides such as those in the valley of the Oise, two sorts of erosions, the one very old, reaching back to the cataclysm of geologists, the other more recent, and still in the process of being formed.

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